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THE MUSKINGUM WATERSHED CONSERVANCY DISTRICT

CHARLES C. HUNTINGTON

Department of Geography,
The Ohio State University

The Muskingum Watershed Conservancy District is an important example of co-operation for resources conservation by the Federal Government, a State, and the people of a local political subdivision. The Muskingum Watershed, a part of the Mississippi Drainage Basin, is the largest in Ohio, including 8,038 square miles. This area, together with the 289 square miles drained by Duck Creek, constitutes about one-fifth of the area of the state. Physiographically, it lies mostly in the unglaciated Appalachian Plateau, the northern and western part, however, being within the glaciated portion. (Plate I.) Politically, the Conservancy District consists of eighteen counties forming a political subdivision whose boundaries follow roughly those of the drainage basin.

From an economic and social point of view, this Conservancy District, created June 3, 1933, under the Conservancy Act of Ohio, passed soon after the great flood of 1913,¹ includes approximately half the major land-use problem areas of the State.² This very hilly section of Ohio was the first settled, but contains large areas not well adapted to arable farming on account of the difficulty of using modern farm machinery, the serious erosion due to the rapid run-off from long denuded slopes and the impoverished soils mostly of sandstone and shale origin.

The average yearly rainfall of the area is approximately 39 inches, but the run-off is high especially during the winter and

¹Passed February 6, 1914, *Page's Annotated Ohio General Code*, Secs. 1-7994.

²*Major Land-Use Problem Areas and Land Utilization in Ohio*. Dept. of Rural Econ., O. S. U., and Ohio Agr. Exper. Sta. Mim. Bull. No. 79, Map, p. 2.

early spring rains, amounting to 86% for the March, 1913, storm and from 75% to 85% for that of March, 1933. Sherman's chart of mean precipitation and run-off for the years 1910-1918 shows a comparatively uniform rainfall distribution by months for the year, but a relatively high run-off from January to April with a maximum in March when the run-off was 90%.³ The Soil Conservation Service reported a 95% run-off from plowed land in Ohio during the heavy rains of January, 1937.⁴ This high run-off from steep slopes naturally increases the flood hazard.

The floods may be classed as summer floods that occur during the crop season, usually in localized areas, and winter and early spring floods which are more general and cause most of the damage. The summer rains are often heavy, but fortunately are usually localized within relatively small areas. Thus, on July 16, 1914, at Cambridge, Ohio, 7.09 inches fell in an hour and a half.⁵ This remarkably intense storm was decidedly limited in area, however, decreasing rapidly in intensity in all directions until the half inch isohyet bounded it from three to five miles from the weather bureau station which just happened to be at the center of the storm.⁶ Sudden and heavy summer rains are common in the Muskingum area, but being local, they are not so costly in flood totals. In fact, practically all of our major floods result from winter and spring rains, which, although perhaps of less intensity than the summer rains, may last longer and often fall on ground already wet or frozen.

At the beginning of the glacial period the surface of most of the Muskingum area had a greater relief than now; the rock floors of the pre-glacial valleys now are often buried 150 feet below the present valley bottoms.⁷ The total relief of the unglaciated region, with its mature topography, however, still approximates 500 feet.⁸ The surface of the old plateau, as indicated by the ridge tops, stands some 1,200 feet above the sea. The broad flat-bottomed valleys with their flood

³C. E. Sherman, *Ohio Stream Flow*, Part I, p. 6.

⁴C. F. Brooks and A. H. Thiessen. The Meteorology of Great Floods in the Eastern United States. *Geog. Rev.*, Apr., 1937, p. 272.

⁵W. H. Alexander, *A Climatological History of Ohio*, p. 78.

⁶C. E. Sherman, *The Ohio Water Problem*, p. 16.

⁷G. W. White. Drainage History of North-Central Ohio. *O. Jour. of Science*, Nov., 1934, p. 373.

⁸*Ibid.*, p. 367.

plains and terraces,⁹ contain fertile farm lands, good roads and homes, also many towns and cities with their factories, potteries (Plate II, Fig. 2), and other industries—all hitherto subject to damage by flood.

In the March, 1913, flood, there were estimated direct damages of \$13,600,000 within this District, and these were only a small part of the flood toll, with its loss of life and intangible damages of interrupted business and employment, to which should be added local, state and federal relief expenses. Counties and cities alone in the district spent over \$3,000,000 to repair highways and bridges damaged by the flood of 1913. Other floods as in 1927 and 1933 added strong arguments for conservation.¹⁰ In August, 1935, floods again ravaged the district—the damages of that month's flood within the Muskingum Basin have been estimated by engineers at \$5,500,000. A suggestion of how the flood waters of that month affected business and transportation in the valleys of the District is given in Plate II, Fig. 3, which shows an urban scene where the Tuscarawas and Walhonding rivers join at Coshocton to form the Muskingum.

The difference between high and low water stages is 29 feet at Coshocton, 47.5 feet at Zanesville, 46.2 feet at McConnellsville, and 43.2 feet at Marietta. This great variation in the volume of the Muskingum is also indicated by the fact that while the average flow at its mouth is about 8,200 second-feet, the range is from a minimum of about 450 feet to a maximum of some 282,000 feet per second.¹¹

The hydrographic pattern of the Muskingum Basin is such that, within a few days after heavy rains general over the drainage area, its two main branches and their wide-spreading tributaries rapidly concentrate the bulk of the run-off at Coshocton, 109 miles above the mouth of the Muskingum, and then at Dresden, where the Muskingum River, leaving the wide pre-Illinoian valley through which most of the basin above Zanesville formerly drained westward toward Newark, has cut its relatively narrow modern valley southward to Zanesville. Here, joined by the Licking and augmented by the

⁹Width, extent and character of many of these valleys may be seen clearly on the U. S. G. S. Topographic Sheets: Ohio Quadrangles of Millersburg, Uhrichsville, Coshocton, Newark, Frazeyburg and Marietta.

¹⁰W. T. Buckley, The Ohio River Flood of March, 1933. *O. Jour. of Sc.*, March, 1933, p. 67.

¹¹C. E. Sherman, *Ohio Stream Flow*, Part I, p. 62.

waters of Wakatomika and Wills Creeks, main tributaries of the Muskingum between Coshocton and Zanesville, the Muskingum enters a still narrower gorge in which flood waters have risen higher above low water mark than in any other valley within the state. On March 28, 1913, for example, the flood water rose 44.8 feet above low water mark at Lock 10 at Zanesville.¹²

As a comprehensive program of flood control and water conservation, the Muskingum Watershed Conservancy District is developing a system involving a large key reservoir on each of the two main branches of the Muskingum, together with a dozen more on their tributary streams. (Plate I.) The plan is to have as nearly as practical, equal distribution throughout the basin of both water conservation and flood control. The project will control some two-thirds of the Walhonding and Tuscarawas drainage areas and five-sevenths of the whole Muskingum basin above Zanesville. These reservoirs, at maximum flood elevation, include 77,730 acres, of which 65% was flooded in 1913. The project is designed to protect against a storm 36% greater than that of 1913. That is, ten inches of rainfall in five days, in all parts of the basin above Zanesville, with a run-off of 90% or nine inches. This control would be sufficient to lower the flood crest below that of 1913 by 6.3 feet at Marietta, 10.6 feet at Coshocton, and 15.3 feet at Zanesville.¹³ The 1913 storm was used as a basis for calculations because it was the greatest storm and flood of record in the Muskingum Basin. At that time, the heaviest rainfall was in the northern part of the Basin, extending from Bangorville (10.56 in.) to Akron (9.85 in.).¹⁴

Four reservoirs are provided for the Walhonding Basin, the Key reservoir, the Mohawk, fifteen miles northwest of Coshocton on the Walhonding River, having its dam where the valley narrows between a terrace on the south side and a steep cliff

¹²C. E. Sherman, *Ohio Stream Flow*, Part I, pp. 58 and 98.

R. E. Lamborn, *The Newark Drainage System in Knox, Licking and Northern Fairfield Counties*, *O. Jour. of Sc.*, 32: 449 (1932).

Wilbur Stout and G. F. Lamb, *Physiographic Features of Southeastern Ohio*, *O. Jour. of Sc.* 38: 71-77 (1938).

See also Zanesville, Philo, McConnelsville and Caldwell (Ohio) Quadrangles.

¹³Official Plan for the Muskingum Watershed. Conservancy District. (Revised June 5, 1935), Vol. I, p. 21.

¹⁴For figures and maps of the March, 1913, rainfall and flood in the Muskingum Valley, see A. H. Horton and H. J. Jackson, *The Ohio River Flood of March-April, 1913*. U. S. G. S. Water Supply Paper No. 334. Also, C. E. Sherman, *Ohio Water Problem*, p. 9 et seq.

on the other.¹⁵ This dam will not form a permanent lake, its entire storage capacity of 7,950 acres being designed for flood control alone. In the January, 1937, flood, this dam, incomplected and with gates not closed, created a lake 39 feet deep. The river at normal times will flow through two large outlet tunnels through this dam, one of which penetrates the cliff of sandstone and interstratified sandstone and shale, which constitute the Mississippian formations occurring in the western third of the watershed. In the eastern two-thirds of the Muskingum basin these formations are overlaid with the Pennsylvanian formations, which average 1,100 feet in thickness. (Geol. Survey of Ohio, 4th Series, Bull. 26, p. 104.)

The Mohawk Dam is 111 feet high and 2,330 feet long. It is of earth and rock fill and is estimated to cost \$2,292,763. A view from its down-stream side shows the river emerging from the twin tunnels. (Plate II, Fig. 4.) This dam was completed during the summer and fall of 1937. If the reservoir, in times of flood, is ever filled to capacity, which may never happen, it can overflow through the spillway in a saddle just to the right (north) of the cliff, which is joined to the upland by a narrow ridge.

Each dam of the Muskingum Project is provided with such an overflow spillway, and wherever possible these are located in saddles isolated from the main dam as illustrated in Fig. 5 of Plate II for the Clendening Dam. One of the outlet tunnels for the Clendening reservoir penetrates this same cliff. These outlets are constructed so as to take care of maximum capacity required under minimum head and have more than one opening as may be seen at the Wills Creek Dam. (Plate III, Fig. 6.) On the down-stream side the concrete outlet widens into a stilling basin, constructed to slow down the rushing flood waters. How this operates is apparent from the photo taken at the Mohicanville Dam January 27, 1927. (Plate III, Fig. 7.) The outlet openings, stilling basin, and spillways of the Charles Mill Dam, the first one completed, may be seen in the view looking upstream (Fig. 11). As a result of this dam some of the valley land above will be flooded by a permanent lake of 1,350 acres. A photograph taken from this dam, January 27, 1937 (Fig. 8), shows this reservoir about 6 feet deeper than the permanent lake planned. During the January, 1937, flood,

¹⁵Brinkhaven Quadrangle.

even the gates of the completed dams could not be closed because not all of the reservoir land had yet been purchased and (Fig. 12) vast volumes of the flood water rushed through with the "jump" intended by the construction of the stilling basin. All but three of the reservoirs were to have permanent lakes, varying in size from 350 to 3,550 acres. These were to be available to the public for boating, fishing and for cottage sites. Their combined shorelines total some 200 miles, or about equal to Ohio's frontage on Lake Erie. Practically all of this frontage is privately controlled. This is the case with almost all the areas around Ohio's inland lakes. Plate IV, Fig. 15, shows part of the lake at the Leesville Dam as it appeared in April, 1937, and indicates its beautiful setting. This was planned to be a permanent lake of 1,200 acres.

These lakes would occupy only the bottom parts of the reservoirs and were intended to store water for beneficial uses, the most important of which is the stream flow regulation required to provide during dry seasons the water necessary in the valleys below for domestic and industrial uses, satisfactory sanitary conditions, and maintenance of water table requirements for agriculture.

Notwithstanding the obvious advantages of these permanent lakes and their tremendous importance for water conservation and recreation, objections on the grounds of prospective taxation have arisen, particularly in Stark County. Litigation originating there has resulted in court decisions, which, unless additional funds are obtained from the State or Federal government, make improbable any immediate development of more than two or three, if any, of the proposed permanent lakes. In fact, April 29, 1938, the Director of the District announced they were restricting land purchases to the flood control program, but expressed a willingness to co-operate with any agencies interested in promoting the additional funds required for lakes and parks.

Fig. 11, Plate III, a picture of the Charles Mill Dam August, 1936, shows: the spillway, the stilling basin, and the outlets each provided with gates to maintain the water conservation level of the permanent lake, and to regulate the flow of the flood waters. Each gate is controlled from the gate house above.

Each of the fourteen dams in the District will be operated by gate keepers who will live in modern brick cottages (Fig. 10),

built by the U. S. Government as part of the construction of every dam. These tenders will operate the gates during storms or drouths, in fact at all times, according to instructions from a central office of the Conservancy District. They will also keep regular rainfall records, take stream gauge readings, etc., as part of a comprehensive schedule for the entire system.

An aerial view (Fig. 13) of Charles Mill dam shows not only the farms below, but also how advantage has been taken of the narrowing of the present valley due to a terrace on the left (east) and a hill on the right connected by a saddle of glacial drift to the west wall of the preglacial valley.¹⁶ All but two of the reservoirs occupy valleys antedating the glacial times, whose rock floors are deeply buried by glacial material or land waste, and whose dissected interfluves give irregular shape to farm lands.

The Pleasant Hill Dam on Clear Fork of the Mohican River, five miles southwest of Loudonville, has been constructed in a relatively young rock-cut gorge amidst beautiful scenery (Fig. 14). This is evidenced by the view down stream through its steep sided and heavily wooded gorge which leads toward the Mohican State Forest.¹⁷ The co-operation of the State Forestry Department and of fish, game, and other conservation organizations of the State promises to make the recreation facilities within the Muskingum District one of its important accomplishments.

Another dam, the Atwood, has likewise been located in a young valley, on Indian Fork of Conotton Creek, but this young part of its valley is quite short, and the reservoir will be in the preglacial valley beyond.¹⁸ This dam was completed in July, 1937.

The other narrow, steep-walled post-glacial valley being utilized for a dam is that of the Tuscarawas River, whose Key reservoir is the only one with an all concrete dam. (Fig. 9.) This, the Dover Dam, 3½ miles northeast of the city of that name is now completed and has cost \$1,618,702, including a levee to protect the historic communistic village of Zoar. The permanent lake here would be the smallest of the eleven,

¹⁶Perrysville Quadrangle (Ashland Co., Ohio).

¹⁷Clear Fork leaves its old preglacial valley some two miles above the dam site and flows south and east, probably five miles through this attractive gorge until it joins Black Fork. G. W. White, Drainage History of North Central Ohio. *O. Jour. of Sci.*, Nov., 1934, p. 379.

¹⁸Dover Quadrangle.

only 350 acres, but the flood reservoir capacity will be over 10,000 acres (10,100). (Plate V, Fig. 17.) Looking upstream can be seen the village of Zoarville, to be abandoned, also farms, fields, and orchards between the wood lots on the steep hillsides, the highway raised to skirt the dam on the left, and a branch of the Pennsylvania R. R. on the right. Relocating six miles of this railroad from its old route near the river's edge to a higher level is costing Uncle Sam \$605,756. The seventy miles of railroad relocations in the Conservancy District are being paid for by the Federal Government, at a total cost of over \$5,000,000.

(Plate V, Fig. 18.) Nine miles northwest of Dover in a mile-wide preglacial valley¹⁹ the Beach City Dam requires a half million dollar relocation of the B. & O. R. R. from the valley to a flat surfaced terrace 30 to 35 feet high and 3,200 feet wide. Looking east and south from this dam can be seen some of the roads and fine farms to be protected below the dam.

This 4,800 feet long dam, like the Leesville Dam (Fig. 15),²⁰ the Senecaville Dam (Fig. 21) completed in the middle of May, 1937, in fact, like all except the Dover Dam, is of earthen construction with concrete spillways and outlets. Some rock is used for filling and, (Fig. 22) as illustrated at the Piedmont Dam, for rip-rapping the lower portion of the dam. Above this Piedmont Dam (Fig. 23), completed 1937, may be seen a portion of U. S. Highway No. 22 which would be drowned by its 2,700 acre permanent lake.²¹ (Plate IV, Fig. 16.) Just below this dam can be seen nestled in the valley the village of Piedmont, which will no longer fear a flood.

At the Wills Creek Dam, too, (Plate V, Fig. 20) the highway had to be raised from the valley to the hillside on the right above the dam. At the Tappan Dam (Fig. 19), now finished, a great deal of road-filling had to be done as the new highway, State Route 250 crosses one branch of the flood reservoir. A mile above this dam the village of Tappan, entirely within the proposed lake (2,350 acres), had to be abandoned.²² All of three villages and parts of eleven others were to be relocated or abandoned as, for example, part of Walhonding, above the

¹⁹Navarre Quadrangle.

²⁰Scio Quadrangle (Carroll Co.).

²¹Flushing Quadrangle (Harrison Co.).

²²Scio Quadrangle (where Willis Run enters Little Stillwater Creek).

Mohawk Dam. All such villages were given their choice of abandonment or removal to a new site.

The village of Plainfield has taken the latter choice. (Fig. 25.) Situated in a bend of Wills Creek, nearly all of the century-old town, except the school house, is below the maximum level of the flood-control reservoir. A new site above this level was purchased by the District and laid off into lots, with new streets, commons, and parks, to which the houses, stores, churches, etc., of the residents will be moved during the summer of 1938. In May, 1937, it was announced that many of the residents of Sandyville had agreed to removal and that bids would be received at the Muskingum Watershed Conservancy District's offices in New Philadelphia up to June 16 for moving the greater part of the village by December 1 to a new site half a mile northeast.²³ The remainder of the village is to be protected by a levee, as the present site will be affected by the reservoir of the Bolivar Dam on Sandy Creek.²⁴ Magnolia, Brewster and Zoar are other villages to receive adequate levee protection, with no moving required.²⁵

The responsibility and cost of acquiring all land for such removals as well as that for acquiring the property, easements, and rights of way for the dams, reservoirs, levees, and various public utility, road, and other relocations fall upon the property owners of the District who are to receive flood control and other benefits. This total land cost has been estimated at \$7,260,000, the largest amounts per county being in Tuscarawas (\$1,934,570) and Coshocton (\$1,058,174) Counties. The number of pieces of property listed as benefited or damaged had in 1937 reached 32,000. About 60,000 acres had already been acquired or contracted for by the District, notwithstanding delays due to litigation, etc.²⁶

²³The Daily Reporter, Dover, Ohio, May 18, 1937.

²⁴Dover Quadrangle, Tuscarawas Co.

²⁵It is reported that many residents of Zoarville now regret their decision to sell out individually and let the town be abandoned. Some of them and also certain farmers complain that their property was appraised only at present value, which is, they say, not enough for them to buy or build elsewhere on a rapidly rising market. The railroads, they say, got for their old property everything new, as ties, rails, bridges, etc., when they were relocated. Dover, Ohio, Daily Reporter, May 22, 1937.

²⁶Mr. Hal Jenkins' Letter of May 3, 1937.

A proposed \$1,500,000 issue of general property tax bonds was held unauthorized by the Fifth District Court of Appeals, as it was for recreation or conservation purposes, so the District is compelled for lack of funds to limit its activities to flood control. (M. W. C. D. News Release, April 29, 1938.)

The benefited properties are credited with about \$14,000,000 increase in valuation, approximately twice the assessed damages. Thus the assessments on benefited property-owners would be about 50% of their increase in valuation. These assessments may be paid over a period of 30 years. Over 70% of this assessed benefit valuation is in the three river counties of Muskingum (\$5,601,541), Tuscarawas (\$3,049,324), and Washington (\$1,211,909), in the order named.

Two million dollars has already been appropriated by the Ohio General Assembly towards the Conservancy District's share of the cost, and the Ohio State Highway Department and Federal Bureau of Public Roads are paying for all highway relocations (150 miles; estimated cost \$8,804,753). The highway relocations were about 50% complete at the end of April, 1937.

The balance of the cost of this \$43,000,000 project (\$27,190,000: \$22,090,000 granted by P.W.A. in 1933; an additional Federal grant of \$3,500,000 in 1936; and \$1,600,000 in February, 1937),²⁷ has all been contributed by the Federal Government, which through the United States Corps of Engineers is in charge of construction of all dams and public utility relocations. The public utility relocations include 13 miles of oil lines, 75 miles of gas pipe lines, 65 miles of power lines, and 270 miles of telephone and telegraph lines.

When construction (begun January, 1935) is completed (by June, 1938, it is expected) the United States Corps of Engineers will turn the entire project over to the District for operation and perpetual maintenance. One of the tangible benefits of the project to date has been the employment furnished. The first year it reached a peak of 4,000. During 1936 it averaged 4,500 weekly, with a peak of 5,178 one week. The average 1936 pay roll was \$125,000 weekly. It was, of course, lower last year, as the work was more nearly completed.

May 14, 1937, at Cambridge, the people of the Zanesville-Cambridge section of the District celebrated the dedication of the Senecaville Dam (Plate VI, Fig. 21) just completed. It is 52 feet high and nearly half a mile long and is located nine miles southeast of Cambridge on the Seneca Fork of Wills

²⁷This P.W.A. grant of \$1,600,000 by Executive Order of the President, according to Mr. Bryce C. Browning, Secy.-Treas. of the District, meant that they could resume land purchases and yet keep their pledge to benefited property holders that their assessments would not be over \$6,000,000. Ohio State Journal, Columbus, Ohio, February 18, 1937.

Creek. Its permanent lake (Fig. 24) then covering some 1,200 acres will be the largest in the Conservancy District, 3,550 acres, while its flood reservoir capacity will be 5,170 acres. This permanent lake will be larger than Buckeye Lake and exceeded in Ohio only by Indian Lake and St. Mary's. Seneca Fork's crooked valley traverses beautifully wooded hills and when filled, the lake will extend seven miles to Batesville in Noble County.

The benefits of this conservancy project cannot be measured in dollars alone.²⁸ While its main purpose is flood control and its second objective is water conservation, it also has for its ultimate goal proper land utilization, soil conservation, reforestation, wild life preservation, and better opportunities for outdoor life and recreation. Already there have been established within the District three demonstration projects for the prevention of soil erosion, a large tree nursery of the Soil Conservation Service near Zanesville, and at Coshocton a big laboratory for hydrologic, soil and water studies. This project, the government officials claim, has been located here because the results of the study can readily be utilized in the work of the Muskingum Conservancy District.

There some 25 or 30 persons, mostly scientists and engineers, will study soil and water losses from the complete Muskingum Watershed. Lysimeters (water meters) and various devices have been installed to chart the rain that falls, what soaks into the ground or runs off under different conditions of cover, soil, slope, terracing, etc.; to gauge stream flow; to observe silting. In short, for the first time to carry out a project on a scale broad enough to base definite conclusions. This may take four or five years but from the facts learned, it is hoped to determine proper soil and water conservation practices.²⁹

Another project now established, throughout the Muskingum Basin under the direction of Dr. C. Warren Thornthwaite, Chief of the Physiographic and Climatic Research Division of the Soil Conservation Service, promises much aid to the Conservancy District. It has set up 500 stations throughout

²⁸Of the approximately \$14,000,000 increase in property values originally listed as due to the District's flood control project, some \$8,000,000 consisted of benefits to private and industrial property, over \$2,760,000 benefits to public utility property and more than \$3,200,000 of benefits to public property. *M. W. C. D. News Release* of Mar. 5, 1936. Sheet 2.

²⁹Statement of Mr. W. D. Ellison, S. C. S. Hydraulic Engineer. *Columbus Dispatch*, March 21 and April 2, 1937.

the watershed where observers have taken readings at half hour intervals of rainfall, wind direction and velocity, and temperature. Daily maps covering the area will aid in the study of storms, their intensity, and their migrations. This should aid greatly in determining flood hazards.³⁰

The Muskingum Project has already attracted much attention not only throughout the United States but also in Canada and in Europe. In March, 1937, nine members of the National House of Representatives flood control committee inspected the dams of the District, with a view to its possible importance as an example for other projects in the Ohio and Mississippi Valleys.³¹

Unlike the dams in the Miami Conservancy District in which the conduits are just large enough to permit sufficient water to go through to fill the stream channels below, with the excess water automatically backing up behind the dams, the Muskingum Dams, on account of the larger area and more complicated tributary system involved, will be controlled by steel gates operated by men directed from the Central Office which is in touch with all parts of the system. The conduits are larger than the channel capacities below, and as fast as the channels can accommodate the water after the passing of a flood crest one or more of the gates can be raised gradually, thus releasing water above the level of the permanent lake.

For facilitating water supply operations, seven of the dams have cast iron pipe lines imbedded in their concrete outlet works. Thus, without disturbing the structure, the District can easily connect with feeder lines, to furnish water from the permanent reservoirs for city, industrial or domestic use when needed.

During the January rains of 1937, on account of not yet owning all the necessary reservoir lands, the District could not close the gates at any of the dams, yet they automatically held back sufficient water to fill practically all of the reservoirs to permanent lake level or more, thus resulting in a lowering of flood crests from two to five feet and contributing to a lessened flood damage at critical points in the valleys below.³² No flood

³⁰Personal interview with Dr. Thornthwaite. Also information furnished by Mr. Hal Jenkins and Mr. Bryce C. Browning for the Amer. Forestry Association under date of Apr. 14, 1937.

³¹See *Ohio State Jour.*, Mar. 31, 1937.

³²Estimates of C. C. Chambers, Chief Engineer for the Conservancy District. See also *Columbus Dispatch*, Jan. 24, 1937.

has come to test these great dams since the last one was finished early in February, 1938, but for flood control they are ready when the test does come.

ACKNOWLEDGMENTS

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OFFICIAL PLAN OF RESERVOIRS*

NAME OF RESERVOIR	STREAM	DRAIN-AGE AREA Note (A) Sq. Mi.	ELEVATIONS		AREA	
			Spillway El. Line Feet	Conser. Pool, Feet	Flood Reservoir Acres	Perma- nent Lake Acres
Wills Creek....	Wills Creek...	723	779	742	11,450	900
Senecaville.....	Seneca Fork...	121	842.5	832.2	5,170	3,550
Mohawk.....	Walhonding River.....	817	890	799.2	7,950	0
Pleasant Hill...	Clear Fork....	199	1,065	1,020	2,600	850
Charles Mill...	Black Fork....	216	1,020	977	6,050	1,350
Mohicanville....	Lake Fork....	269	963	932	8,800	0
Tappan.....	Lt. Stillwater Creek.....	71	909	899.3	3,100	2,350
Clendenning....	Brushy Fork...	70	910.5	898	2,620	1,800
Piedmont.....	Stillwater Cr..	84	924.6	913	3,200	2,270
Beach City....	Sugar Creek...	300	976.5	948	6,150	420
Dover.....	Tuscarawas River.....	777	916	874	10,100	350
Bolivar.....	Sandy Creek...	502	962	895	6,500	0
Atwood.....	Indian Fork...	70	941	928	2,570	1,540
Leesville.....	McGuire Cr...	48	977.5	964	1,470	1,000
Totals.....		4,267			77,730	16,380

Note (A)—Less area reservoired above.

EFFECT OF OFFICIAL RESERVOIR PLAN ON MARCH, 1913, FLOOD*

Critical Point	Stream	Flood Stage, Ft.	Flood of 1913	Reduction, Feet
Walhonding River:				
Loudonville....	Black Fork.....	....	....	6.0
Warsaw.....	Walhonding River...	....	....	10.7
Tuscarawas River:				
Sherrodsville....	Conotton Creek....	....	....	— 1.0
Dover.....	Tuscarawas River...	7.0	16.1	7.8
N. Philadelphia..	Tuscarawas River...	....	....	7.1
Dennison.....	Lt. Stillwater Creek.	....	....	(a)
Uhrichsville....	Stillwater Creek....	11.0	17.3	3.8
Tuscarawas....	Tuscarawas River...	....	....	6.4
Gnadenhutten....	Tuscarawas River...	....	....	6.2
Port Washington	Tuscarawas River...	....	....	8.0
Newcomertown..	Tuscarawas River...	15.0	21.0	9.5
West Lafayette..	Tuscarawas River...	....	....	7.2
Freeport.....	Stillwater Creek....	....	....	4.0
Muskingum River:				
Coshocton.....	Muskingum River...	8.0	28.8	10.6
Cambridge.....	Wills Creek.....	....	....	3.7
Dresden.....	Muskingum River...	....	....	14.4
Zanesville.....	Muskingum River...	33.0	51.8	15.3
McConnelsville..	Muskingum River...	15.3	35.1	14.2
Marietta.....	Muskingum River...	28.0	59.8	6.3

(a) Practically same as Uhrichsville.

*Compiled from the Official Plans for the Muskingum Watershed Conservancy District, Vol. I, Revised ed. of June 5, 1935.



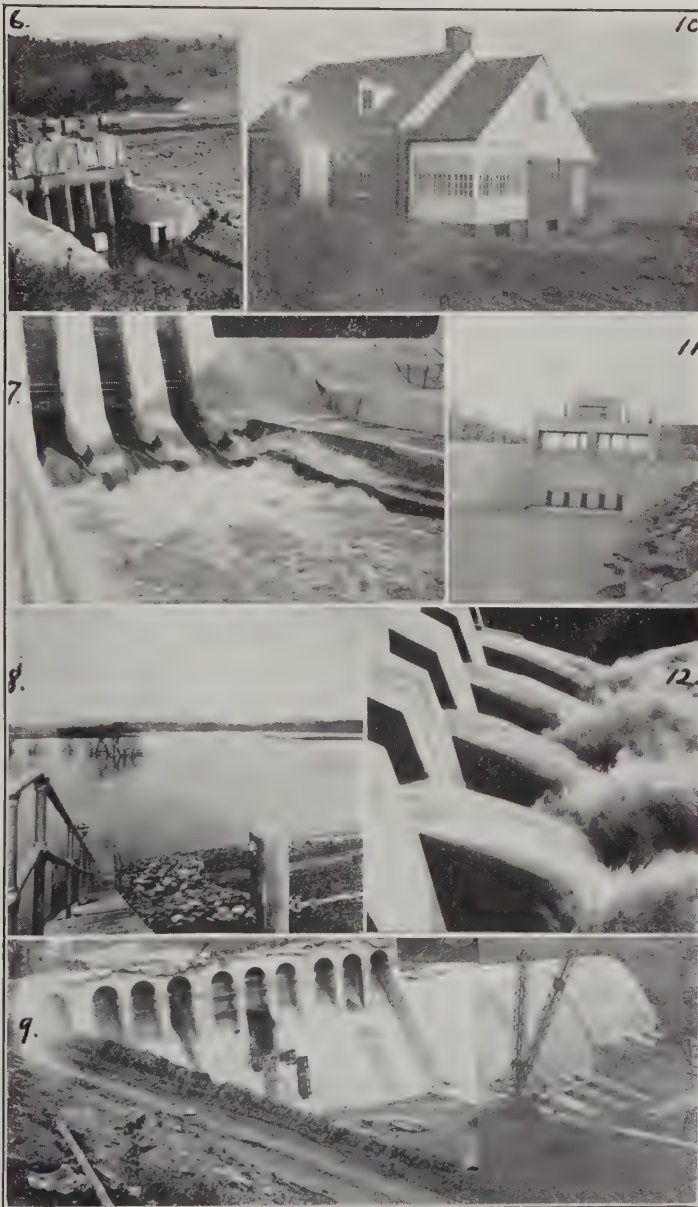
EXPLANATION OF PLATE II

- Fig. 2. Universal Potteries, Inc., South side of Cambridge (looking across Wills Creek Valley).
- Fig. 3. Flood at Coshocton (looking north), August, 1935. Waterworks plant in center near bridges over Tuscarawas River. Glimpse of Walhonding at left. (These two rivers unite to form the Muskingum about a block southwest of the bridges.) Photo courtesy of Hal Jenkins.
- Fig. 4. North end of Mohawk Dam (looking west upstream), Walhonding emerging from Twin tunnels. Photo by John Getz.
- Fig. 5. Clendenning Spillway being cut through solid rock. (View westward into valley below. Dam is just to left of foreground.)



EXPLANATION OF PLATE III

- Fig. 6. Concrete Outlets of Wills Creek Dam. Gate house under construction above outlet. (Looking north downstream at part of valley below) September, 1936.
- Fig. 7. Mohicanville Dam Spillway, gate guarded outlets and flood waters flowing into basin below. (Looking north upstream) January 27, 1937.
- Fig. 8. Lake at Charles Mill Dam. Looking north from spillway. (Water surface about 6 feet above permanent lake surface.)
- Fig. 9. Dover Dam seen from below. Outlets and stilling basin below at right. (Only west half of dam constructed then; nearly as much more to be added on the right.) Photo taken November, 1936.
- Fig. 10. Gate operator's cottage, Mohicanville Dam. Part of dam visible in the background at the right. (Looking north upstream.)
- Fig. 11. Charles Mill Spillway, Stilling Basin, Outlets, and Gatehouse above. (Looking upstream.)
- Fig. 12. Charles Mill Dam. Outlets in action, January flood, 1937.



EXPLANATION OF PLATE IV

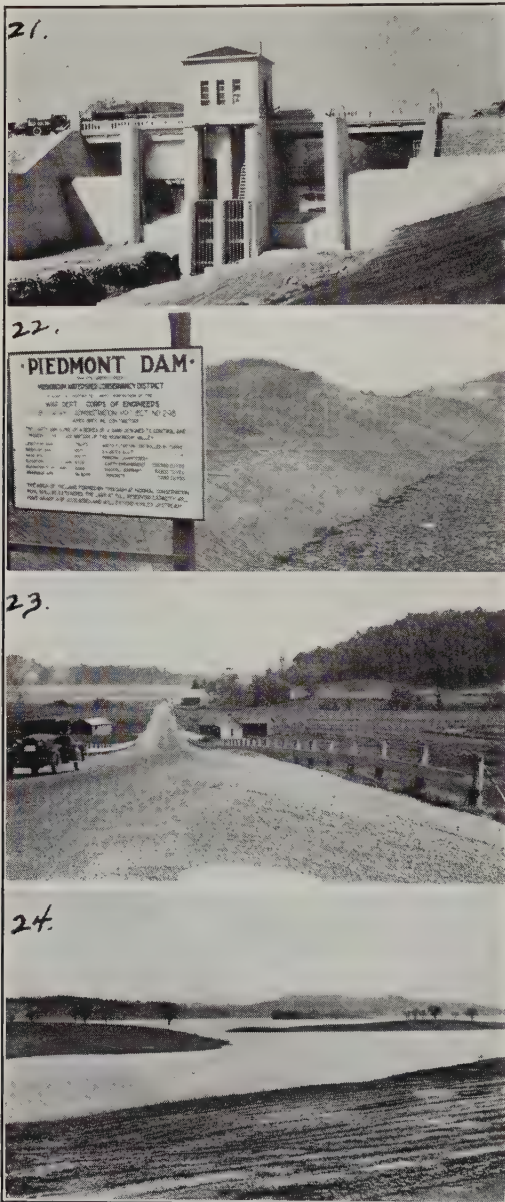
- Fig. 13. Birdseye view of Charles Mill Dam and surrounding country. (Looking southwest downstream.) Note: Change in road to come around left end of dam on glacial terrace; school building in foreground to be abandoned; and spillway at foot of bed rock hill, which connects by a saddle of glacial drift to west wall of preglacial valley nearly a mile to the west.
- Fig. 14. Site of Pleasant Hill Dam (looking northwest upstream). Dam 775 feet long and 113 feet high has since been constructed between the two temporary bridges, and extends from wooded cliff on left to wooded slope on right. Valley bottom here is 250 feet wide and its steep walls rise from the stream level of 964 feet to the rugged upland about 1,200 feet above sea level.
- Fig. 15. Leesville Dam and part of Lake (looking west). Most of earthen dam is visible at the left, while at right above the concrete outlet works, the gate keeper's house may be seen. This photo and the two above, courtesy of Hal Jenkins, whose silhouette appears below. April, 1937.
- Fig. 16. Village of Piedmont as seen from the dam. (Looking north downstream, September, 1936.)



EXPLANATION OF PLATE V

- Fig. 17. Dover Dam and the Gorge of the Tuscarawas River. (Looking north and upstream to village of Zoarville, soon to be abandoned.) Note: hill-side orchards and farm lands separated by wooded ravines and slopes; State route No. 8 surmounting west abutment of dam; and new track of Penna. R. R. elevated from old line at right of stream.
- Fig. 18. View of Beach City Dam and surrounding country. (Looking southeast downstream.) Long earthen dam in center; B. & O. R. R. moved from valley to terrace on left; roads and farms in mile-wide preglacial valley.
- Fig. 19. Tappan Dam from above. (Looking north.) Gate house and dam have since been finished. State highway No. 250 elevated to height of north end of dam, which is 52 feet high and 1,600 feet long.
- Fig. 20. Wills Creek Dam (under construction September, 1936). Looking upstream can be seen cornfield in valley at left of creek and on right close to stream, old road that had to be elevated to position above at right.





EXPLANATION OF PLATE VI

Fig. 21. Senecaville Dam (looking west to wooded slopes of valley below). Below are barred outlets whose heavy steel gates control level of permanent lake and flow of flood waters, by means of machinery operated by tender in gate house above. This dam was dedicated May 14, 1937.

Fig. 22. Piedmont Dam (lower side looking west). Below at right is part of the rock riprapping protecting lower half of the dam. Gate tender's cottage is seen at west end of dam.

Fig. 23. Piedmont Dam (looking north down U. S. Route 22, to be relocated to make way for permanent lake).

Fig. 24. Senecaville Lake (looking northeast from point near south end of dam) April, 1937. Lake then about 1,200 acres, to be increased to 3,550 acres.

THE SUPRAMARGINAL RIDGE IN CERTAIN AMERICAN SNAILS

DAVID T. JONES,

Associate Professor of Zoology, University of Utah
(on leave of absence for one year);

Assistant in Microscopical Anatomy,
Indiana University School of Medicine

INTRODUCTION

It is well known that the periostracum of mussels and clams is secreted in a groove of the mantle margin alongside a roll of high columnar cells (Jones, 1925-27, Figs. 11 and 13). Few persons, however, are aware that the periostracum of the snail shell is secreted from its mantle margin in essentially the same way, from a supramarginal groove in front of a supramarginal ridge (Jones, 1935, Plate I). In the bibliography of a previous article (Jones, 1935) are references which will lead those interested to the literature.

In Europe, Burkhardt, Roth, and others have studied the supramarginal ridge of *Helix pomatia*; Matthes, *Helix pisana*; Eckhardt, *Vitrina pellucida*; Beck, *Buliminus obscurus*; Napela, *Helix arbustorum*; not to mention the works of Longe and Mer, Moynier de Villepoix, Simroth, Zill, Biedermann, Annandale, Prashad, and others. In this same article is described the mantle of the tiger snail, now designated as *Discus alternatus* (Say), one of the very few descriptions of the mantle margin of an American snail. The present article attempts to present the comparative histology of the mantle margins of twenty-one additional species of American snails, as to the ridges and grooves in the periostracum secreting region. While such an article must necessarily be more or less superficial, the comparative view of a wide section of the field cannot but be helpful in promoting later more detailed studies. The former is beyond the immediate reach of the average graduate student, but the latter constitutes a compact, delimited problem.

Before selecting the sections to be drawn, several hundred research slides in the author's private collection were studied. Most of these are on mantles, among which are included several recently prepared serials to help solve doubtful points. European

and Asiatic specimens in this collection were disregarded, as these sections confirm drawings already available in the literature. In most cases sections of from three to eight or ten individuals have been studied. In a few cases, which are noted, sections from one specimen alone have been presented, where these seem to have been cut squarely across. Not only has variation between individuals in the same species made selection of sections difficult, but also variation of ridges and grooves within the same mantle. For example, the phase of a ridge on the columellar lip of the mantle may appear very different from the phase of the same ridge on the outer lip. Personal judgment has had to be used rather arbitrarily in the selection of good sections. In most cases one of the more complex phases was selected, because therein could be demonstrated the most of the more-frequently-occurring structures, which one comes to regard as "characteristics" for that species.

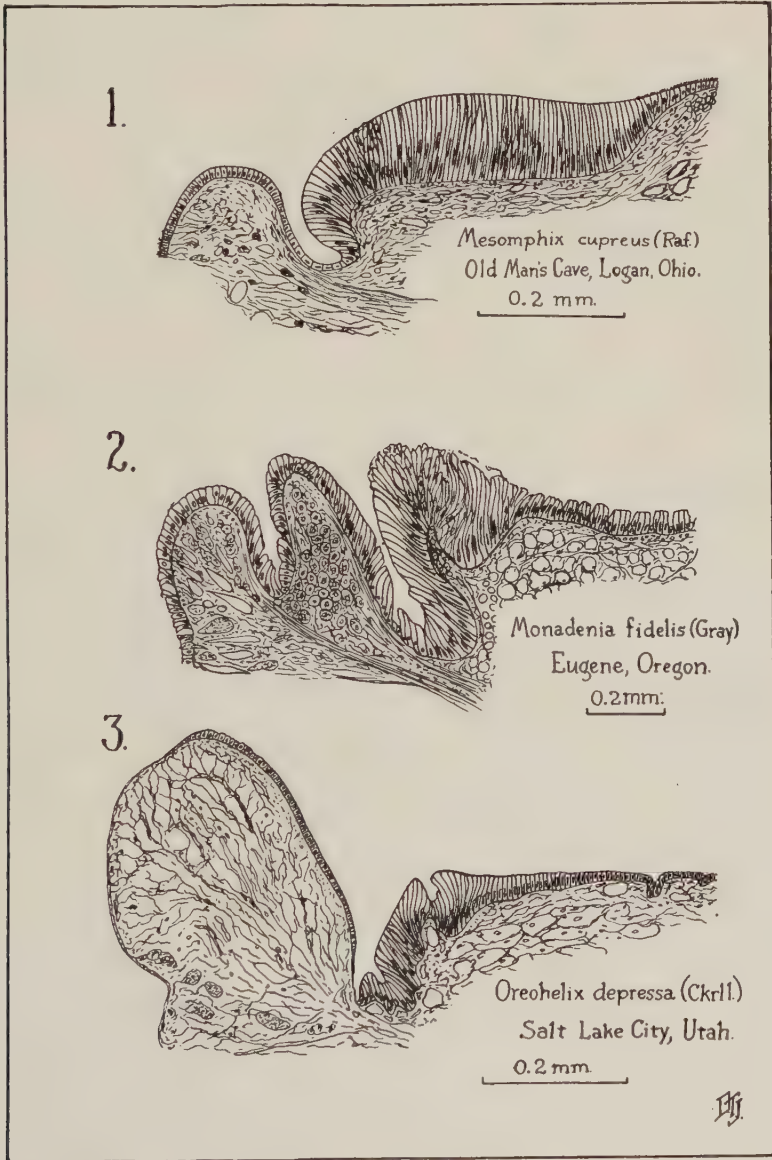
As to nomenclature, in Figure 2 the supramarginal ridge is shown as the heightened epithelium continuous with the low epithelium on the reader's right. To the left of this is the supramarginal groove, to the left of which is an "intermediate ridge," to the left of which in turn is a "secondary groove," to the left of which again is the "frontal ridge," the left margin of which is continuous with the front of the mantle. The terms in quotation marks are purely arbitrary, assigned for convenience in the following descriptions.

DESCRIPTIONS AND DISCUSSIONS OF FIGURES

Figures 1, 2 and 3 are introductory, representing the mantle edge of a large land snail from each of the three great snail regions of America respectively. Figure 1, of *Mesomphix cupreus* is of a snail commonly occurring in southern Ohio and West Virginia. It has a fragile shell covered with smooth shining periostracum. These mantles tend to show a flattened supramarginal ridge at least on the outer lip of the mantle, often extending on to the columellar lip also. Some individuals show the ridge divided into two, three, or more flaps, similar to that of another species shown in figure 14. This condition, when present, is usually more pronounced on the outer lip of the mantle.

Monadenia fidelis, the beautifully colored, heavy shelled snail of the Oregon region, has a shining periostracum. The outer edge of its mantle (fig. 2) has a double groove which usually extends over to the columellar side. Usually the secondary groove is non-secretory, but here it appears to be secretory. It is not known whether the two grooves function simultaneously. The intermediate ridge between the two grooves is of variable height. Flaps of clear epithelial cells, similar to the one shown, tend to project into the supramarginal groove

from its floor. The crest of the supramarginal ridge is often formed of sinuously curved cells, which shatter when cut.



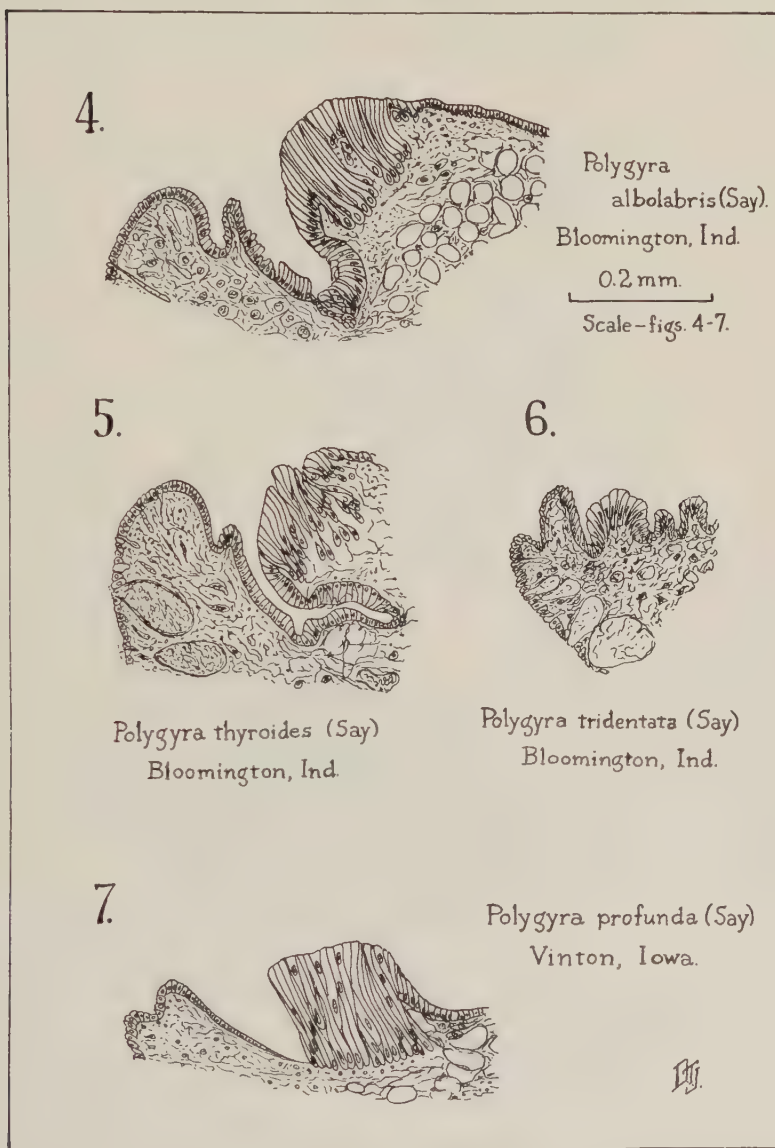
Oreohelix depressa, the widespread land snail of the Great Basin, has a heavy, irregularly-ribbed shell, which has very little periostracum in the mature specimens. The supramarginal ridge and groove are

very variable. On the outer lip of the mantle, the former may be as complex as that shown (fig. 3). An unusual situation is occasionally found, where large unicellular mucous cells empty into the supramarginal groove. There is a tendency for the supramarginal ridge to be divided into flap-like groups of cells. The mantle margin does not greatly resemble that of most of the groups of large land snails. Some of the above features arouse suspicion that the supramarginal ridge may involute to some degree after shell maturity has been reached, though our present material is insufficient to so conclude.

Many of the *Polygyra* examined (figs. 4 and 5) show a basal grouping of the tall cells of the supramarginal ridge. Such has been reported, not only in European *Helices*, but also in certain of the Viviparidae (aquatic) by Prashad. It appears as a downgrowth from the ridge of groups of epithelial cells into the connective tissue beneath. The supramarginal ridge (but not the intermediate ridge) is usually obsolete on the columellar side of the mantle. This is a very confusing situation to analyze until the continuity of the ridges can be traced in serials. The supramarginal groove sometimes has a pocket-like cleft, not always continuous in the floor, as shown in figure 5. It is difficult, even with a number of slides, to know whether to interpret these as pockets in the floor of the groove, or as twisted sections of the groove recut. The intermediate ridge, varying in size and shape, is usually present, and with the groove usually continues onto the columellar side of the mantle.

In my material, *Polygyra albolabris* (fig. 4) shows little difference between individuals. *Polygyra thyroides* (fig. 5) is essentially of the same plan as *albolabris*. However, in *Polygyra tridentata* (fig. 6) the mantle edge exhibits a barely-differentiated supramarginal ridge, though the intermediate ridge is prominent. Scant material of *Polygyra monodon* (Rackett), not figured, shows even less differentiation. Slides of *Polygyra profunda* show considerable individual variation, ranging from the type figured (fig. 7) to one showing an obsolete supramarginal ridge, but with a more pronounced intermediate ridge. European workers have suggested in such cases that the supramarginal ridge may disappear after the shell reaches maturity. (Sexual maturity is attained in most snails long before shell maturity, the latter marking that stage when additions to the shell cease.) Unfigured material of *Polygyra elevata* (Say) shows a condition intermediate between the figures of *P. thyroides* (fig. 5) and *P. profunda* (fig. 7), but with high columnar epithelium on both slopes of the supramarginal groove, also with the supramarginal ridge merging more gradually with the epithelium beneath the shell. *Polygyra palliata* (Say) (mantle figured by Jones, 1937, fig. 5r), is also of special interest, because of the evenly-arranged, hair-like spines of periostracum covering its shell. Where and how these are formed are as yet unexplained. One European malacologist, working with a pilose shell, advanced the hasty conclusion that the "hairs" were pressed into shape as the horny periostracal material was pressed between the two slopes of the supramarginal groove as it was emerging, a semiliquid mass. This explanation, however, could hardly apply, as smooth shells have as pronounced similar mantle structures. In *P. palliata* there is the possibility of

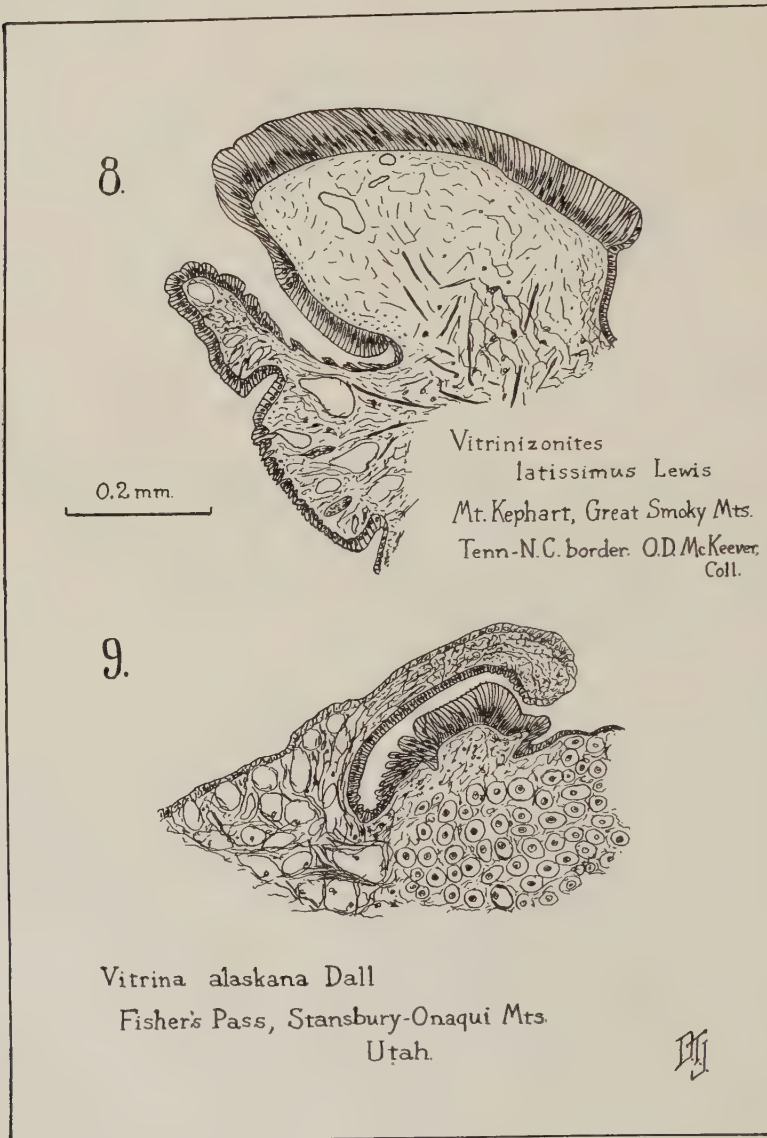
either a groove modification or a deep pocket in the bottom of the groove; my material admits of ambiguous interpretation. Clear



cut sections of *Polygyra appressa* (Say) were not drawn, as they were so nearly like the figure shown for *P. thyroides* (fig. 5).

Eckhardt's bizarre figures of the mantle of *Vitrina pellucida* from the Alps, aroused curiosity as to our species of *Vitrina*. I have been

unable to secure live specimens of our eastern *Vitrina*, but the western *alaskana* shows equally as bizarre patterns, one of which is drawn (fig. 9). Here the frontal ridge sometimes arches over the much-



lobulated supramarginal ridge, in a way such as to suggest the manipulating or shaping of the fragile membranous shell, which often has so little calcareous backing that it collapses when touched. On

this side of the Atlantic, we are fortunate in having a queer giant vitrinoid, *Vitrinizonites latissimus*, supposedly a mutant glacial relict, now isolated in the Great Smoky Mountains. Of those which O. D.

10.

Haplotrema concavum (Say)
Bloomington, Ind.

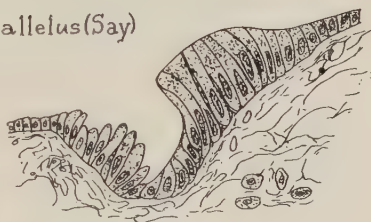
0.2 mm.



11.

Helicodiscus parallelus (Say)
Bloomington, Ind.

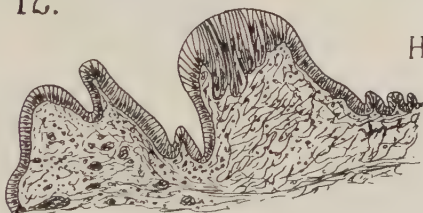
0.05 mm.



12.

Helminthoglypta sp.
Montebello, Calif.

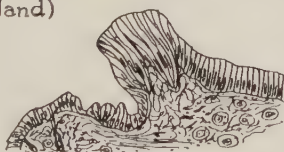
0.2 mm.



13.

Microphysula ingersolli (Bland)
Salt Lake City, Utah

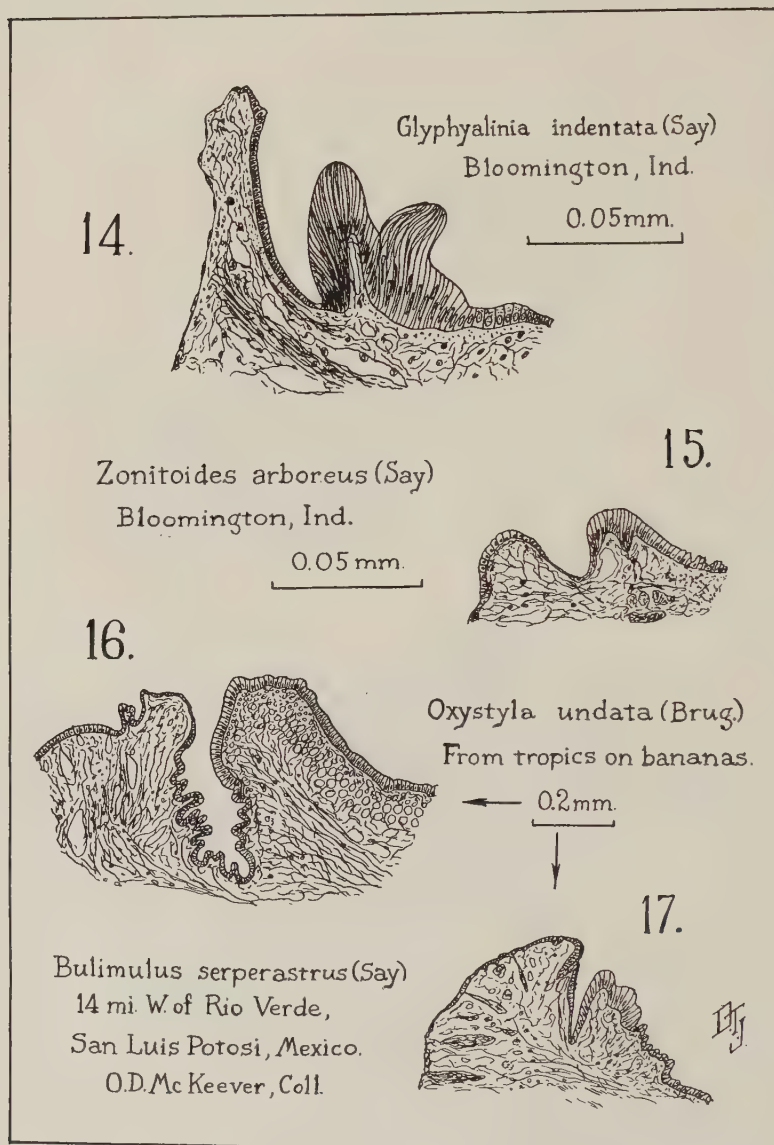
0.1 mm.



McKeever attempted to send me, only one came through alive. From sections of this, I have drawn the queer mantle margin shown in figure 9, which shows many *Vitrina* modifications. When investigated more

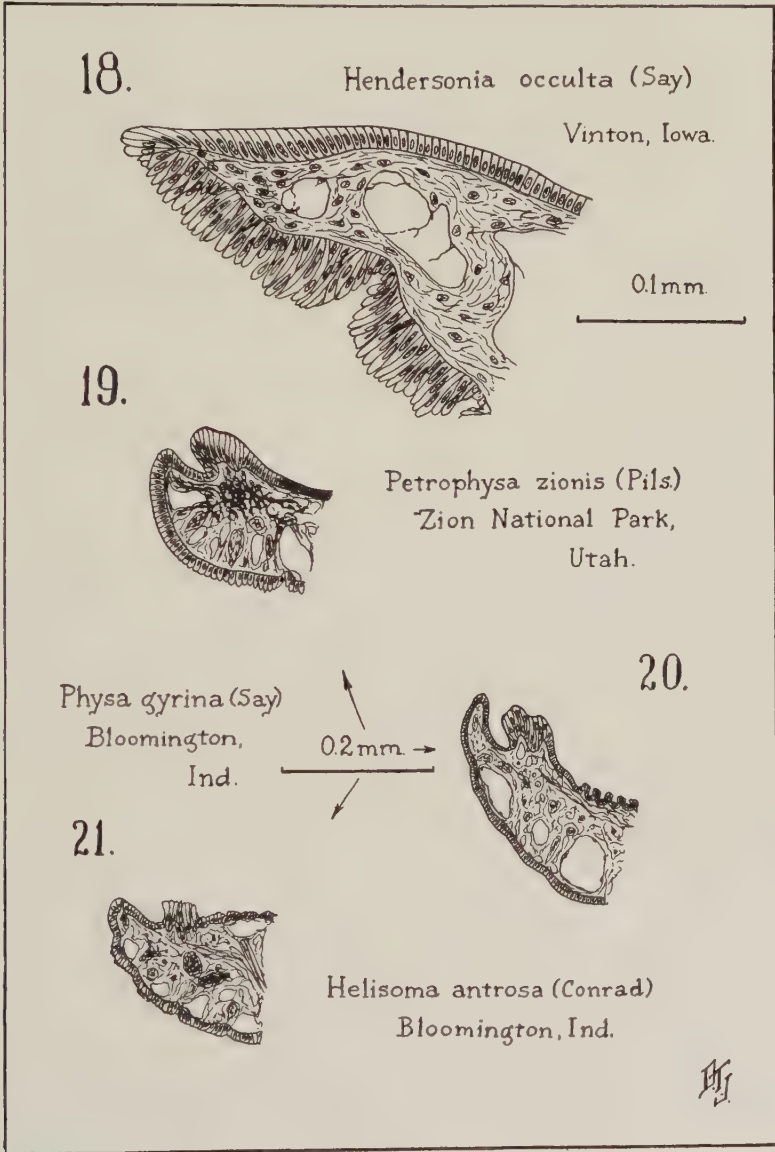
thoroughly, it may show as much variation within one mantle as is shown by the western *Vitrina*.

Haplotrema concavum, the only eastern representative of this green-



shelled, carnivorous genus, exhibits a pattern (fig. 10) quite its own. The ridge is usually sharp-pointed, and is composed of long cells twisted out of one plane, which generally causes the ridge to break when sec-

tioned. *Helminthoglypta*, probably *tudicatula* (Binney), is the only one of that genus of large California land snails examined (fig. 12). Note its similarity to *Polygyra* (figures 4 and 5), also to *Monadenia*



(fig. 2). In other specimens this *Helminthoglypta* shows a more prominent intermediate ridge than the one figured, which separates off a distinct secondary groove that may be secretory as in *Monadenia*.

In some specimens both grooves are present on both inner (columellar) and outer lips of the mantle.

Among the small snails the endodont, *Helicodiscus parallelus* (fig. 11) exhibits a clear-cut, but extremely simple supramarginal ridge and groove, usually only on the outer lip of its mantle. *Microphysula ingersolli* (fig. 13), a small Utah helicid, shows more complex tendencies toward the helicid structure of *Polygyra*. Sections of only one specimen of pupillid, *Gastrocoptera armifera* (Say), unfigured, show a short supra-marginal ridge approximately five cells in length. The ridge is less sharply defined than in *Microphysula*, and the groove is barely differentiated. The mantle of *Zonitoides arboreus* (fig. 15) shows a structure simpler than that of the helicids, tending, with great variation, as much perhaps in that direction, as toward the glassy snails, with which it is commonly allied systematically. As has been mentioned, another large zonitoid, *Mesophix cupreus* (fig. 1) tends even more strongly toward *Vitrea* than the figure shows. The only one of the ordinary glassy snails (*Vitrea*) examined was *Glyphyalinia indentata*. It shows a very variable supramarginal ridge, which may be split as shown (fig. 14). Cells just back of the supramarginal ridge show golden granules in the Golgi region. Of course, *Vitrina* (fig. 9) and *Vitrinizonites* (fig. 8) are considered closely allied to *Vitrea*, but as shown their mantle margins are much more highly differentiated.

Of Neotropical land snails, I have examined only two, the *Oxystyla* that seals itself on bananas and is thus imported to our northern states, and several specimens of *Bulimulus serperastrus* (fig. 17) shipped alive to me by O. D. McKeever. The former (fig. 16), a single specimen, shows no heightening of the epithelium over a connective-tissue ridge. The supramarginal groove is well developed.

In this survey the simplest ridge found was that of *Helicodiscus parallelus* (fig. 11). However, one land snail, *Hendersonia oculata* is reputed to be far more primitive (H. B. Baker, 1925). As it is found only in isolated patches in widely scattered regions, it is not readily accessible. However, I had previously found it in the vicinity of Vinton, Iowa (Jones, 1930, also 1931). From this locality mantles were first secured which showed no supramarginal ridge or groove. Dubious of these observations, some years later, several whole animals were secured and sectioned serially. While some of these sections were not cut in the right direction for the study of these parts, a few were. Careful study of these reveals no ridge or groove, either on the outer mantle (fig. 18) or on the inner strap-like mantle. It is possible that the simplicity in this mantle may not be correlated with its primitiveness, but with the fact that the shell is practically devoid of periostracum when fully developed.

Another primitive mollusk described by Pilsbry (1925), *Petrophysa zionis*, lives on the vertical walls of Zion National Park, where water trickles over the cliff. Last year, Perry Plummer brought several back to Salt Lake City alive, but most did not fix well. However, a few show on the outer lip (fig. 19), and also to some extent on the inner, a ridge and a groove, not much different from that of the eastern pond snail, *Physa gyrina* (fig. 20). The *Physa* mantle has much epithelial

pigment in the region back of the supramarginal ridge. Subepithelial pigment may also be present. The only other mantle of a native aquatic snail observed has been that of the planorbid, *Helisoma antrosa* (fig. 21).

In conclusion, may it be re-emphasized that the limits of variation of mantle ridges and grooves should be intensively studied for each snail, both within single mantles, and between different individuals of the same species. Little is known at present of the correlation between mantle structures and the shell. Mantle ridges and grooves may serve other functions than merely secreting the periostracum, as shaping the drying periostracum, clasping and protecting the recently-formed edges of the shell, stiffening the mantle edge for support of such membranous shells as that of *Vitrina*, or closing the space between the deeper mantle and the shell, not only for protection but also to conserve shell-forming liquids. Most digitations of the mantle arise from the front of the mantle rather than from the mantle margin, where the above-described ridges and grooves are located.

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Variable Stars

This little book tells the story of stars which fluctuate in brightness. The author is one of the best of the Mt. Wilson astronomers and the story, unpretentiously told, is on the whole to his credit.

The opening chapter, done in question and answer style intended to engage the reader, is inclined to suggest instead that the author is a little nervous in getting started. Once the first uneasiness is passed, however, the story is admirably told.

The chapter on the history and cataloging of variable stars is particularly interesting in that it gives an excellent idea of the typical early childhood of an astronomical problem. The rest of the book is largely explanatory of the physical conditions prevailing in such stars. The only disappointing feature of the book is the very inadequate chapter of Novae, those stars which occasionally burst forth with approximately a million times their normal brightness.

The book is written for those people who have an interest in and an elementary knowledge of astronomical phenomena.—*C. E. Hesthal*.

The Nature of Variable Stars, by Paul W. Merrill. 134 pp. New York, The Macmillan Company, 1938. \$2.00.

SPIDERS AND INSECTS FOUND ASSOCIATED WITH SWEET CORN WITH NOTES ON THE FOOD AND HABITS OF SOME SPECIES*

I. ARACHNIDA AND COLEOPTERA

RAY THOMAS EVERLY,
Holmesville, Ohio

During June, July and August, 1935, while engaged on some field work with the European Corn Borer Research at Toledo, Ohio, opportunity was presented to make a cursory collection of the spiders and insects found upon the corn plants, or upon the ground in the corn field.

The field in which the collections and observations were made was planted to sweet corn and contained approximately four acres. During the latter part of June, July and the early part of August, series of plants, scattered over the entire field, were examined daily. This factor contributes largely to the extensive and diverse numbers of species and makes the collections representative of the entire population.

The following list does not in anyway attempt to portray a complete picture of the Arthropod population of the corn field, but rather merely indicates the tremendous number of species present in a limited area during a limited season. However, the field where this collection was made can not be considered as a normal habitat, as it was part of the European Corn Borer Research Plots and of necessity was treated much differently than an ordinary field of sweet corn. In addition to the usual cultivation operations, the plants were subjected to almost constant disturbance, due to examinations for egg masses, tasselling and silking, and population dissections. Very few extraneous plants were present in the field as in addition to the horse cultivation, the plots were hoed several times, and any weeds found during the examinations of the corn plants were destroyed. Several other factors tended to operate in reducing the number of species collected in this particular case. The collections were made incidental to the routine work or after working hours and it was impossible to pursue specimens any

*The families under each order, the genera under each family, and the species of each genus are listed alphabetically. This facilitates the locating of any desired species by those unfamiliar with a phylogenetic arrangement.

distance. In addition bulky collecting equipment such as nets, boxes, etc., could not be carried. All specimens were taken either in small vials moistened with alcohol or in small cyanide bottles. Due to this fact many of the more delicate specimens were injured and could not be determined to species. Therefore it can be safely assumed that a collection made with proper equipment in a randomly selected corn field would yield far more species.

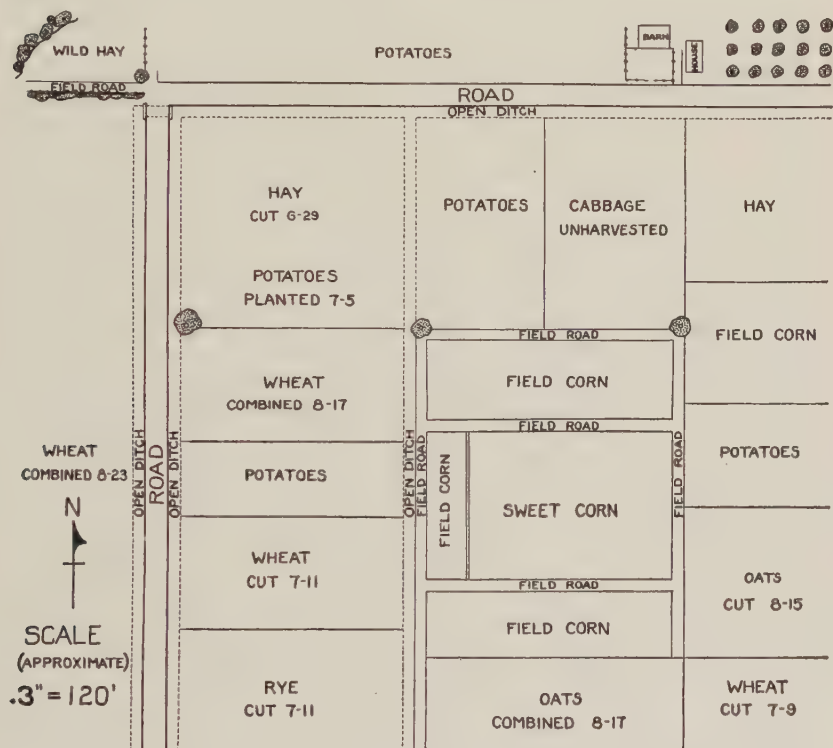


FIG. 1

This field of sweet corn was located just north of Maumee, Ohio, in Lucas County. The plots were surrounded by farmland of the intensive cultivation type, there being very few fence rows and little woodland. In the accompanying plan it will be noted that the only near place for hibernation and growth of extraneous plants were in the deep drainage ditches common to this section of Ohio. To the northwest of the field, approximately half a mile, was a small stream with rather heavily

wooded banks. Three oak trees grew within a few hundred yards of the field, and to the northeast of the field was a small apple orchard. Southwest of the field, approximately three hundred yards, was another older orchard and the farm buildings (see figure 1).

Extraneous plants found most commonly in the vicinity of the corn field were in the drainage ditch which ran along the west side of the field. The more common plants in this ditch were Canada Thistle (*Cirsium arvense* (L.)), dogbane or Indian Hemp (*Apocynum cannabinum* L.), smartweed (*Persicaria* sp.), wild lettuce (*Lactuca* sp.), burdock (*Arctium minus* Schk.), several species of mints (*Mentha* sp.), teasel (*Dipsacus sylvestris* Huds.), white sweet clover (*Melilotus alba* Desv.), and yellow sweet clover (*M. officinalis* (L.)), many species of grasses (*Poa* sp.), butterfly weed (*Asclepias tuberosa* L.), bindweed (*Convolvulus* sp.), alfalfa (*Medicago sativa* L.), sour grass (*Oxalis* sp.), blue elderberry (*Sambucus canadensis* L.), poison ivy (*Toxicodendron radicans* (L.)), hackberry (*Celtis occidentalis* L.), wild rose (*Rosa* sp.), wild grape (*Vitis* sp.), and willow (*Salix* sp.). These wild plants and cultivated plants in the surrounding fields may account for many of the casual visitants taken upon the corn. In the corn field itself, dogbane, milkweed (*Asclepias syriaca* L.), black nightshade (*Solanum nigrum* Nutt.), and smartweed were most common, especially in the roadways of the plots in the late summer.

Assistance is hereby acknowledged to Mr. Morris Schlosberg and Mr. Ralph Mathes for specimens and some observations, and to Mrs. Laura W. Everly for mounting and labeling the specimens, for aid in the determinations of the Carabidae and for assistance with the manuscript. Particular thanks are due to Mr. C. F. W. Muesebeck of the Bureau of Entomology and Plant Quarantine for granting the facilities of his staff of specialists in the determinations of the bulk of the species. Credit for determinations are given under the respective families.

ARACHNIDA

The Arachnida are perhaps more representative of the population found in the cornfield than the insects as means of escaping capture were more limited. The jumping spiders and the crab spiders were abundant throughout the season. During the latter part of August the web spinning spiders were most

numerous, particularly *Tetragnatha laboriosa* Htz. The irregular webs of this species were to be found on practically every corn plant and individuals were commonly observed mating in the webs. The following list gives the species taken. Determinations were made by Professor W. M. Barrows.

Agelenidae

Agelena sp.? (young)—Taken July 31.

Argiopidae

Aranea sp.? (young)—Two specimens taken July 8 and 9.

Aranea (see *Epeira*).

Argiope aurantia Lucas—Taken August 7.

Epeira or *Aranea thaddeus* Hentz (young)—Taken July 11.

Eustala anastera (McCook)—Male taken July 15.

Mangora gibberosa Hentz—Two females, one male and a young specimen taken July 17 to August 9.

Metargiope trifasciata Forskal—Two females taken August 9 to 15.

Neoscona arabesca Walckenaer—Female taken July 30.

Neoscona pratensis (Hentz)—Male taken August 7. This is the first record for this species in the state.

Tetragnatha laboriosa Hentz—First specimens taken July 8. Common during August. One specimen taken as the prey of a young *Phidippus* sp. (Family Attidae) taken July 31.

Clubionidae

Castianeira descripta Hentz—Two females taken on July 28.

Clubionidae sp.—Two specimens taken July 25 and August 1, which could be determined only to family.

Attidae

Attidae sp.—Four immature specimens taken July 18 to August 3.

Derridyphrantes capitatus Em.—Three males taken July 17 to August 5.

Icius sp.—One specimen taken July 18, too poorly preserved for determination.

Phidippus sp.—Two young specimens taken July 31 and August 1.
(See Family Argiopidae, *Tetragnatha laboriosa* Hentz.)

Phidippus insolens Hentz—Four males taken July 21 to August 2.

Phidippus sp.—Maybe *multiformis* of McCook female taken July 23.

Dictynidae

Dictyna sp.—One female specimen taken late in August.

Dictyna longispina Em.—One male and one female taken on July 10.

Linyphiidae

Bathyphantes sp.?—Close to *albomaculatus* Bks. taken July 9.

Ceraticelus formosus Banks—One male taken July 10.

Lycosidae

Lycosidae sp.—Immature specimen taken July 10.

Lycosa erratica Hentz—Female taken under corn debris on ground July 6.

Theridiidae

Theridium differens Em.—One male taken July 18.

Thomisidae

Coriarachne versicolor Keyserling—Female taken July 8.

Misumena sp.—Two young specimens taken July 11 and August 1.

Misumessus sp.—Probably *asperatus* Hentz young, taken August 7.

Tibellus oblongus (Walck.)—Taken July 24.

Thanatus sp.—Probably *lycosides* Em. young, taken August 5.

Thomisidae sp.—Too young for determination, taken August 5.

Xysticus sp.—Two immature specimens taken August 2 and 5.

INSECTA

COLEOPTERA

Anthicidae

This family occurred in fairly abundant numbers both on the corn plants and under corn debris about the field. Determinations were made by Mr. J. N. Knull and Mr. H. S. Barber.

Anthicus cervinus Laf.—Three specimens taken June 25, July 18, and August 2.

Anthicus (*Lappus*) *obscurus* Laf.—One specimen taken July 9.

Anthicus sp.—One specimen taken July 25.

Lappus (see *Anthicus*).

Notoxus anchora Hentz—Three specimens taken June 24 to 28.

Notoxus monodon Fab.—Five specimens taken June 26 to July 14.

Cantharidae

This family was not so abundant as some of the others. Determinations were made by Mr. H. S. Barber.

Cantharis carolina F.—One specimen taken July 13.

Cantharis sp. (immature)—One specimen taken July 15.

Podabris tomentosus Say—Very common in the field and upon the corn plants. Three specimens taken July 5 to 11.

Silis latilobus Blatch.—One female taken late August.

Carabidae

The family of Ground beetles was very abundant both on the plants as well as on the surface of the ground about the plants. Many were taken under corn and weed debris on the ground. Determinations were made by Mrs. L. W. Everly and R. T. Everly. Professor W. C. Stehr reviewed the Harpalini and his corrections are incorporated herein.

Abacidus sculptilis (Lec.)—One specimen taken June 24 under debris.

Agonoderus comma Fab.—Eleven specimens taken June 26 to August 2.

This species was abundant throughout the field, usually occurring under debris.

Amara fallax Lec.—One specimen taken June 27.

Amara polita Lec.—One specimen taken July 5 under debris.

Anadaptus baltimorensis (Say)—One specimen taken July 25.

Anisotarsus terminatus (Say)—Twenty-two specimens taken June 27 to July 28.

This species was quite common under debris of weeds and corn about the edge of the field.

Anisotarsus sayi Blatch.—Two specimens taken July 5.

Bemidion constrictum Lec.—Four specimens taken August 5 to 14 under debris where ground was moist.

Bembidion quadrimaculatum L.—Forty-nine specimens taken June 24 to late August.

This species was abundant throughout the season, especially after rains when the ground was still moist. Also taken on moist soil under corn and weed debris.

Blechrus glabratus Duft.—Forty-five specimens taken June 24 to August 9.

Very abundant throughout the field about the base of the plants and under moist debris. This genus was the most abundant of the Carabidae observed in the field.

Blechrus pusio Lec.—Fifty-nine specimens taken June 24 to August 14 in the same habitat as *B. glabratus*.

Bradytus exarata (Dej.)—Two specimens taken June 27, 28.

Bradytus apricarius (Payk.)—Two specimens taken July 5, under debris.

Casnonia pennsylvanica L.—Four specimens taken August 5 to late August. Not abundant, occurring under debris.

Chlaenius tomentosus Say—One specimen taken August 5, crawling on the roadway of the plot.

Clivina bipustulata Fab.—Two specimens taken August 7 and 12.

This species occurred under debris. One individual was very light colored.

Clivina ferrea Lec.—Four specimens taken June 29 to August 5. Agrees with key and description but much lighter in coloration. Found under debris in association with *Clivina impressifrons*.

Clivina impressifrons Lec.—Twelve specimens taken June 27 to August 7.

Very common under debris when ground was slightly moist.

Curtonotus pennsylvanicus (Hayw.)—One specimen taken June 28.

Eumolops furtiva (Lec.)—Three specimens taken June 27 to late August under debris.

Galerita janus Fabr.—One specimen taken August 2.

Harpalus caliginosus Fab.—Six specimens taken July 8 to August 7.

This species was quite abundant under debris in the field. Generally found in burrows about three to three and one-half inches deep, at an angle of approximately 45 degrees to the surface of the soil. Two of the above specimens were much smaller but agreed with the descriptions in other respects.

Harpalus compar Lec.—Two specimens taken June 25 to July 5 under debris.

Harpalus erraticus Say—One specimen taken June 28.

Harpalus herbivagus Say—Six specimens taken June 27 to late August. Quite variable in size and for the most part taken under moist debris.

Harpalus pennsylvanicus DeG.—Nine specimens taken July 5 to August 5. Quite common under debris.

Harpalus longicollis Lec.—One specimen taken August 5 under debris.

Harpalus erythropus Dej.—Twelve specimens taken June 25 to July 19. Common under debris.

Harpalus viridiaeneus Beauv.—Three specimens taken June 27 to late August, under weed and corn debris.

Lebia bivittata Fab.—Nine specimens taken June 25 to late August.

This species generally occurred on the ground at the base of the plants or under moist debris. Several specimens were observed upon the leaves of the corn plants.

Lebia scalpularis Dej.—Eleven specimens taken June 26 to August 2. Generally found under debris or around base of corn plants.

Lebia viridis Say—One specimen, bright blue in color, taken on leaf of corn plant.

Poecilus chalcites Say—Twenty-four specimens taken June 25 to August 5, very abundant under debris and running on surface of ground.

Poecilus lucublandus Say—One specimen taken July 30, under debris.

Platynus placidus Say—Fourteen specimens taken August 1 to late August. Found under moist debris, generally after rains.

Scarites substriatus Hald.—One specimen taken August 5.

Scarites subterraneus Fab.—One specimen taken June 28.

Both of the above species occurred fairly common throughout the season under moist debris.

Stenolophus conjunctus Say—One specimen taken July 5 under debris.

Stenolophus humidus Ham.—One specimen, a female taken, June 28, under debris.

This specimen had been placed as a *conjunctus*, but Professor Stehr called my attention to the fact that the scutellar striae were practically obsolete and the striation of the elytra is very different from *conjunctus*.

Tachys incurvus Say—Twenty-seven specimens taken June 25 to August 5. Very common on moist soil after rains and under moist weeds and corn debris. One pair taken mating on August 5.

Tetragonoderus fasciatus Hald.—One hundred forty-one specimens taken June 24 to August 7. A very abundant species.

This species was observed not only under debris but actively running over the surface of the soil among the plants. One specimen was observed feeding upon the leaves of black nightshade *Solanum nigrum* Nutt., on July 22. This specimen, while under observation, ate a small circular hole through the leaf. The light sandy soil of the field undoubtedly accounts for the abundance of the species, as previously *T. fasciatus* has been taken only in sandy locations.

Tachistodes partarius (Say)—Two specimens taken under debris on June 28.

Triplectrus rusticus (Say)—Thirteen specimens taken June 27 to August 12, quite common in field under debris.

Cerambycidae

This family was abundant upon the milkweed which grew in the cornfield late in the summer. Determinations were made by Mr. W. S. Fisher.

Parandra brunnea Fabr.—One specimen taken under corn debris upon the ground August 7.

Tetraopes tetrophthalmus (Forst.)—This species was common upon milkweed in the field. Frequently seen upon the corn plants. Two specimens taken July 14 and 21.

Chrysomelidae

One of the most abundant families in the field. Determinations were made by Mr. J. N. Knull, and Mr. H. S. Barber.

Altica sp.—One specimen taken July 30.

Chaetocnema denticulata (Ill.)—One specimen taken July 23.

Chaetocnema pulicaria Melsh.—Fairly abundant upon the corn plants. Fifteen specimens taken July 9 to August 7.

Chaetocnema sp.—Three specimens taken July 18.

Chrysomela interrupta Auct.—Two specimens taken July 5 to 8.

Chrysomela obsoleta scriptoides Schaeff.—One specimen taken July 5.

Chrysopus auratus Fab.—Three specimens taken July 6 to 8. One specimen was very dark and with a bluish cast to elytra, probably immature. This species was very abundant upon dogbane growing in isolated spots among the corn plants. Specimens were frequently observed upon the corn leaves although never feeding.

Cryptocephalus quadruplex Newm.—One specimen taken July 5.

Diabrotica duodecimpunctata (F.)—Four specimens taken July 8 to August 7.

This species was very abundant. On July 7 an adult was observed feeding upon the anthers of wild rose, growing along the drainage ditch. On July 24 an adult specimen was seen feeding upon the new silk of an ear of sweet corn. It had evidently cut through about one-third of the silks when observed.

Diabrotica longicornis (Say)—This species was not nearly as abundant as the above and occurred much later in the season. Three specimens taken August 2 to late August.

Disonycha triangularis (Say)—This species was very abundant on black nightshade. Taken quite frequently on corn leaves. Three specimens taken July 9 to 13.

Epitrix cucumeris Harris—This species was very abundant upon the corn plants. Two specimens taken July 28 to 30.

Gastroidea polygoni (L.)—One specimen taken July 18.

Glyptina abbreviata Gentn.?—Three specimens taken July 11 to 19.

Lema lecontei Clark.?—Very abundant upon black nightshade growing in roadways of plots. Specimens taken upon corn leaves of plants adjoining areas of nightshade. Pair taken mating on August 5. Taken July 24 to August 3. (Six specimens.)

Lema trilineata Oliv.?—One specimen taken July 22. A larva of this species, determined by Dr. A. G. Boving, was taken as the prey of a nymph of *Perillus bioculatus* (Fab.) (Hemiptera-Pentatomidae), on August 22.

Leptinotarsa decemlineata (Say)—Taken August 5. Probably a casual visitant from the adjoining potato fields.

Orthaltica copalina (F.)—One specimen taken July 15.

Paria sp.—Three specimens taken July 5 to 22.

Phyllobrotica decorata Say—One specimen taken June 27.

Phyllobrotica discoides Fab.—One specimen taken June 25.

Phyllotreta sp.—Six specimens taken July 9 to 15, common upon corn plants.

Psylliodes sp.—Two specimens taken July 10 to 17.

Systema blanda (Melsh.)?—Six specimens taken July 9 to 14.

Systema frontalis (F.)—One specimen taken July 31.

Cicindellidae

Determinations were made by Mr. E. S. Thomas. Although very abundant in late July, only one species of this family was taken. This was *Cicindela punctulata* Oliv. Five specimens were captured from August 5 to August 31. One was observed to capture and devour a small Carabid beetle, probably *Tachys incurvus* Say, which were abundant in the field, especially after rains and on the moist soil under plant debris. One specimen was observed resting upon a corn leaf.

Coccinellidae

This family was probably the most important group of predators in the field and undoubtedly played an underestimated part not only in the reduction of the numbers of corn borer larvae but other insects as well. Approximately eighty to ninety per cent of the corn plants harbored at least one individual of this group, while as many as six specimens were observed upon one plant. The following specimens were determined by Professor W. C. Stehr.

Adalia bipunctata (L.)—One specimen taken July 9.

Brachyacantha ursina (Fab.)—Two specimens taken July 5 and 24.

Ceratomegilla fuscilabris (Muls.)—This species was very abundant in June and again about the middle of August. On July 14 specimens were observed feeding upon corn pollen which had fallen and collected in the base of the leaves. On July 29 a specimen was taken preying upon *Trigonotilus ruficornis* (Geoffroy) (Hemiptera-Miridae.) On July 21, when the corn plants were manually infested with corn borer eggs, on wax papers, ready to hatch, on fifteen plants examined, one-half hour later, six specimens of this species were observed eating the eggs from the papers. To reach these papers the beetles had to climb or drop to the papers, as these papers were attached to the corn plants upon ordinary dress-makers pins. Numerous specimens were observed parasitized, (estimate about .5%). From two of these parasitized specimens *Dinocampus coccinellae* (Schrank) (Hymenoptera-Braconidae) were reared, one on August 7 and the other in late August. It was interesting

to note, that when forcibly separated from the cocoon of the parasite, these parasitized individuals were capable of considerable activity, although none could be induced to feed.

Chilocerus bivulnerus Muls.—One specimen taken July 5.

Coccinella novem-notata Hbst.—This species was fairly abundant about July 5, taken from June 26 to July 21.

Coccinella trifasciata L.—Two specimens taken July 12 and late August.

Cycloneda munda (Say)—Taken from July 5 to 26, not common.

Hippodamia convergens (Guer.)—Taken June 25 to August 5, most common July 5.

This species was observed feeding upon corn pollen which had collected in the base of the corn leaves. This species was not so commonly parasitized as *Ceratomegilla fuscilabris* (Muls.). *Dinocampus coccinellae* (Schränk), was reared from a specimen collected on a corn leaf in late August.

Hippodamia parenthesis (Say)—Taken July 9 to 30, common.

This species was not so commonly parasitized. *Dinocampus coccinellae* was reared from a specimen collected on a corn leaf on July 19.

Hippodamia parenthesis tridens Kby.—One specimen taken July 18.

Hippodamia tredecim-punctata (L.)—This species was very abundant and predominated in the field in late July. Taken July 11 to late August. None were found parasitized, nor were they observed to feed.

Hyperaspis binotata (Say)—One specimen taken July 25.

Hyperaspis undulata (Say)—One specimen taken July 31.

Cryptophagidae

This family was represented by two species in rather abundant numbers. Determinations were made by Mr. W. S. Fisher.

Anchicera ephippiata Zimm.—Twenty-four specimens taken August 1 to late August.

Anchicera ochracea Zimm.?—Six specimens taken August 1.

Anchicera sp.—One specimen taken August 1.

Cucujidae

This family is represented by only one species which occurred abundantly beneath corn debris on the ground. Specimens were determined by Mr. J. N. Knull.

Telephanus velox Hald.—Thirteen specimens taken August 1 to 5.

Curculionidae

This family occurred in rather abundant numbers upon the corn leaves, although none were observed feeding upon the corn. Determinations were made by Mr. L. L. Buchanan.

Amalus haemorrhous Hbst.—One specimen taken July 18.

Centrinapsis perscitus Hbst.—Two specimens taken July 13, 17.

Baris (near *subsimilis* Csy.)—One specimen taken July 8.

Ceutorhynchus neglectus Blatch.—One specimen taken July 18.

Cryptorhynchus lapathi L.—One specimen taken August 13.

- Hypera punctata* Fab.—Five specimens taken July 17 to August 7.
Odontocorhynchus sp.—One specimen taken July 8.
Rhinoncus pyrrhopus Boh.—Seven specimens taken July 11 to August 5.
Sitona hispidula Fab.—One specimen taken August 12.
Smicronyx sp.—One specimen taken July 15.

Elateridae

Species of this family were very abundant both on the corn plants and under debris on the ground. Determinations were made by Mr. J. M. Knull and Mr. W. S. Fisher.

- Aeolus amabilis* (Lec.)—Six specimens taken July 25 to August 1. Common about base of corn plants.
Aeolus elegans Fab.—Eleven specimens taken June 26 to 28, very common under debris and sheaths of leaves at base of plants.
Conoderes auritus Hbst.—Four specimens taken June 24 to 29 in same habitat as the above species.
Conoderes vespertinus (Fab.)—One specimen taken July 28.
Hypnoidius obliquatus Melsh.—Twenty specimens taken June 27 to August 1, very abundant under corn and weed debris.
Hypnoidius pectoralis Say—Seventy-two specimens taken June 27 to August 7, same habitat as above species.
Limoniinus quercinus (Say)—One specimen taken July 5 on corn leaf.

Histeridae

The species of this family were found under debris on the ground. Determinations were made by Mr. J. N. Knull and Mr. H. S. Barber.

- Hister abbreviatus* F.—Two specimens were collected on August 3 and 5.
Hister americanus Payk.—Three specimens taken August 1 to 7.
Phelister subrotundatus (Say)—Four specimens taken June 27 to August 5.

Hydrophilidae

Determinations were made by Mr. L. L. Buchanan.

- Sphaeridium scaraboides* L.—One specimen found under corn debris on the ground on July 17.
Tropisternus glaber Hbst.—One specimen taken July 21, lying on back on ground between the corn rows.

Lampyridae

Determinations were made by Mr. H. S. Barber.

- Photinus pyralis* (L.)—Two specimens taken July 13 and August 13.

Lathriidae

Determinations were made by Mr. W. S. Fisher.

- Melanophthalmus cavicollis* Mann.—Five specimens taken July 15 to August 1, very abundant under corn debris.

Melasidae

Determination was made by Mr. W. S. Fisher.

- Deltometopus amoenicornis* (Say)—One specimen taken on corn leaf on August 9.

Meloidae

Determinations were made by Mr. H. S. Barber.

Epicauta pennsylvanica DeG.—Three specimens taken in late August.

This species was quite numerous in late August feeding upon the corn pollen.

Macrobasis unicolor (Kby.)—One specimen taken July 18.

Melyridae

Determinations were made by Mr. J. N. Knull.

Collops quadrimaculatus Fab.—Eleven specimens taken June 27 to August 3, very abundant upon the corn plants.

Mordellidae

Determined by Mr. H. S. Barber.

Mordella sp.—One specimen taken July 5.

Mycetophagidae

Determined by Mr. W. S. Fisher.

Typhaea stercorea Linn.—One specimen taken August 5.

Mylabridae

Determinations were made by Mr. H. S. Barber.

Chirida guttata Oliv.—One specimen taken July 9.

Chelymorpha cassidea (F.)—One specimen taken August 5.

Metriorhina bivittata (F.)—One specimen taken July 8.

Microrhopala vittata (F.)—One specimen taken August 2.

Nitulidae

Determinations were made by Mr. E. A. Chapin.

Glischrochilus quadrisignatus Say—Ten specimens taken July 14 to August 7.

One specimen taken on July 25 was feeding upon a larva of the European Corn Borer, *Pyrausta nubilalis* Hbn. The larva was still partly in a tunnel near a smut lesion when the specimen was collected.

Phalacridae

Species of this family were very abundant upon tassels and leaves of corn plants evidencing smut infection. Determinations were made by Mr. W. S. Fisher.

Phalacrus politus Melsh.—Very abundant, eighteen specimens taken July 9 to August 13.

Stilbus apicalis (Melsh.)—Five specimens taken July 13 to August 3, not quite as abundant as the above species.

Platystomidae

Determinations were made by Mr. L. L. Buchanan.

Brachytarsus sticticus Boh.—Nine specimens taken July 5 to August 7.

Scarabaeidae

Determinations were made by Mr. E. A. Chapin.

Anomala nigropicta Cst.—One specimen taken July 24.

Ataenius cognatus Lec.—Four specimens taken August 2 to 5 under debris on the ground.

Canthon pilularius L.—Pair taken July 13 shaping a ball of horse manure dropped during cultivation of the corn on July 10-11.

Ligyris gibbosus DeG.—Taken July 19, very abundant just under the surface of the soil under corn and weed debris.

Staphylinidae

Determinations were made by Mr. E. A. Chapin. All of the specimens except as noted, were collected under corn and weed debris upon the ground.

Atheta sp.—Three specimens taken July 15 to 28, on the corn leaves.

Barydoma sp.—One specimen taken July 28.

Coproporus sp.—One specimen taken on corn plant on August 5.

Leptolinus rubripennis Lec.—Taken on August 5, one specimen.

Mycetoporus sp.—Two specimens taken July 15 and August 1.

Philonthus sp.—Three specimens taken July 28 to August 8.

Tenebrionidae

Determined by Mr. E. A. Chapin.

Blapstinus metallicus Fab.—One specimen taken July 9.

Waterfowl Ecology

This little book is the result of an intensive study, over a five-year period, of the blue-winged teal. Most of the study was carried on in two counties of northwestern Iowa, one of the southernmost regions where this duck still nests in abundance. The author made other studies of the blue-winged teal in various mid-western states, and spent a month in its wintering grounds in Mexico.

The chapter headings are an indication of the thoroughness with which the author has discussed the life history and ecology of this bird: Characteristics of the Bird; Breeding Range; Fall Migration; Wintering Grounds; Spring Migration; Courtship and Mating; Nesting; Rearing of Young; Nest Destruction and Juvenile Mortality; Nesting Cover; Rearing Cover; Food Habits; Nesting Populations; Parasites and Disease; Agriculture and Drainage; Breeding, Refuge, and Shooting Areas; Estimating the Yearly Production; Future of the Blue-winged Teal; Summary and Conclusions. The book contains 23 tables and a bibliography of 71 titles, and is illustrated by a color plate, 6 maps, and 31 photographs. The discussion throughout is brief and concise, and is based primarily on the personal observations of the author.

This book is the first complete study of the life history and ecology of a waterfowl ever published. Many practical recommendations in waterfowl management are offered which would be favorable not only to this and other ducks, but to agriculture generally, and to the great sport of duck hunting. This book is one which anyone interested in birds, ecology, wildlife management, or duck hunting would do well to read.—D. J. Borror.

The Blue-Winged Teal, Its Ecology and Management, by Logan J. Bennett. xiv+144 pp. Ames, Iowa, Collegiate Press, Inc., 1938. \$1.50.

AVIAN HOSTS OF THE GENUS ISOSPORA (COCCIDIIDA)*

DONALD C. BOUGHTON†

With the assistance of

RUTH B. BOUGHTON AND JOSEPH VOLK

As a background for studies on avian coccidiosis it is desirable to know which bird-groups are parasitized by the different genera of Coccidia. To this end the present writer (5) listed the records of the presence of *Eimeria* and *Isospora* by bird orders. It was found, in general, that *Eimeria* was associated with the "lower" orders, and *Isospora*, with the "higher." As a further step toward an understanding of the distribution of avian Coccidia, the present paper assembles the species and sub-species of birds which are known to be capable of harboring *Isospora*.

The data for the host list are derived from three sources: records in the literature; certain unpublished records of Dr. Dora P. Henry; and personal observations. The first two are based upon examinations of hosts killed in their natural habitats. This method has the advantage that it often makes possible histological studies. On the other hand, there are at least two objections to this method. In the first place the hosts must be sacrificed; in the second, replicate observations on questionable cases are impossible. This last point is of particular importance. When the decision between infection and non-infection rests upon the interpretation given to the presence of a few oocysts in the digestive tract, as is the case in many instances, it is of particular advantage to be able to re-examine

*Contribution from the Department of Animal and Plant Pathology, The Rockefeller Institute for Medical Research, Princeton, N. J., and from the Baldwin Bird Research Laboratory (No. 33), Gates Mills, Ohio. The author is indebted to Dr. Dora P. Henry, of the University of Washington, for permission to include the unpublished records on some 75 bird species examined by her in California and Washington; to Mr. Charles Stahnke, for permission to examine a number of captive birds in the Washington Park Zoological Gardens, Milwaukee, Wisconsin; to Mr. S. Prentiss Baldwin and his staff of the Baldwin Bird Research Laboratory, Gates Mills, Ohio, for their hearty co-operation during the summer of 1933, which made possible the examination of 237 individual birds representing 30 species; to Louis Ruhe, Inc., New York City, for permission to examine numerous imported birds; and to Mr. Lee S. Crandall, Curator of Birds, New York Zoological Park, New York City, for the opportunity to examine various captive birds and for his invaluable assistance on nomenclature.

†Zoology Department, University of Georgia, Athens, Ga.

the host under conditions such that a passive ingestion of extraneous oocysts can be ruled out. Of necessity, the records on killed specimens have been taken at face value. The records of the present writer are based on examinations of fecal samples of living birds; some of these were wild birds trapped for examination in their natural habitats and others were captive birds in zoological gardens or pet shops. In the latter group, infections may have been acquired after capture from sources not available in the normal habitats of the hosts. This, however, has no bearing upon the main point of the survey, which is to demonstrate the ability of various bird species to harbor *Isospora*. As a matter of fact many captive birds are probably naturally infected and retain chronic infections over long periods. Such a condition is certainly true for captive house sparrows (6) and is presumably true for certain birds of paradise (3, 4).

The list of hosts is arranged by orders and families, according to Wetmore's classification (25). For each bird species (subspecies when possible) the following details are given: scientific name; common name; a generalized geographical range of the host; a reference to the coccidian species involved, whenever noted as such by an observer; a reference to the authority or authorities for the presence of *Isospora*; and the locality in which the observation was made. In so far as possible, the correct scientific names of hosts, according to the latest nomenclature, are employed. The geographical ranges are included merely as an aid in orientation of host species and to emphasize the world-wide distribution of *Isospora*; the significance of natural habitats in regard to source of infection in the case of captive birds has been discussed above. When a species of *Isospora* has been associated with a given host, this fact is indicated by a Roman numeral which refers to the numbered list of coccidian species given in the text; if no name has been employed the notation "*I. sp.*" is used. Authorities for the presence of *Isospora* are indicated by numbers in parentheses, which refer to the numbered list of references at the end of the paper. Unpublished records of Dr. Henry are designated by (14a); when not preceded by a reference to the literature, they constitute new records. The writer's present records are indicated by (*) for captive birds in zoological gardens or pet shops, and by (**) for wild hosts trapped for observation; when not preceded by a reference to a previous observation, these also constitute

new records. All birds reported here for the first time as hosts of *Isospora* are designated by a dagger (†) placed in front of the scientific name.

The following species of avian *Isospora* have been described:

- I. *I. lacazii* (Labbé, 1893) from the goldfinch, lark, and other unnamed birds (16). From subsequent host lists (17, 18), the two hosts can be identified as *Carduelis carduelis carduelis* (Linn.) and *Alauda arvensis arvensis* Linn. respectively. In 1896 Labbé (17) listed 30 passerine hosts of this species and in 1899 (18) added several more, most of which had been reported by Sjöbring in 1897 (21). In his second and third papers (17, 18) Labbé gave the species as *lacazei*, a spelling which has been employed by most authors since that time. As Henry (14) points out, however, the correct spelling is *lacazii* as originally given by Labbé (16).

Synonyms:

- Ia. *I. rivoltae* (Labbé, 1893) from the chaffinch, shrike, titmouse, and other unnamed birds (16). From subsequent host lists, the three hosts can be identified as *Fringilla coelebs coelebs* Linn., *Lanius collurio collurio* (Linn.), *Parus caeruleus caeruleus* Linn. respectively. In his 1896 paper Labbé (17) abandons this species and considers all forms as belonging to *lacazei* (= *lacazii*).
Ib. *I. communis-passerum* Sjöbring, 1897, from a number of passerine birds (21).
- II. *I. lyruri* Galli-Valerio, 1931, from the black grouse, *Lyrurus tetrix tetrix* (Linn.) (9). Later Galli-Valerio (10) reports this species from the capercaillie, *Tetrao urogallus urogallus* Linn.
- III. *I. buteonis* Henry, 1932, from hawks and owls (14). The original host records include: *Accipiter cooperii* (Bonaparte), *Buteo borealis calurus* Cassin, *B. swainsoni* Bonaparte, *Falco sparverius sparverius* Linn., and *Asio flammeus flammeus* (Pontoppidan). A later observation (14a) adds *Bubo virginianus pallescens* Stone.
- IV. *I. strigis* Yakimoff and Matschoulsky, 1937, from the short-eared owl, *Asio flammeus leucopsis* (Brem) (29).
- V. *I. nucifragae* Galli Valerio, 1933, from the nutcracker, *Nucifraga caryocatactes caryocatactes* (Linn.) (11).
- VI. *I. volki* Boughton, 1937, from Lawes' six-plumed bird of paradise, *Parotia lawesi lawesi* Ramsay and 10 other birds of paradise (4).
- VII. *I. monedulae* Yakimoff and Matschoulsky, 1936, from the collared jackdaw, *Corvus monedula collaris* Drummond (28).
- I. henryi* originally described (26) from *Bubo bubo bubo* has been placed in the genus *Caryospora* (27), which is not considered in this paper.

It is not clear from the text of Labbé's 1896 paper (17) whether or not he re-examined the five hosts originally reported (16), but in the present host list he is given credit for so doing.

Records for hosts listed by Labbé in 1899 (18) but not given in his earlier papers are not attributed to him in this paper if they had been published by Sjöbring in 1897 (21). The latter (21) includes two hosts without giving species names (*Fringilla* sp. and *Sylvia* sp.), for which no notation is given in the present host list. Hadley (12) and Johnson (15) incorrectly placed the coccidia found by them in certain passerine birds in the genera *Eimeria* and *Cyclospora* respectively. Sufficient evidence has been presented (22, 1) to show that they were actually dealing with *Isospora*, and their records are included here.

It is not the purpose of this paper to discuss the species of avian *Isospora* in detail, but rather to organize our present knowledge of the distribution of the genus in bird hosts. However, a few remarks on the difficulties of species description in this group may be in order, especially since these difficulties seem to have been too easily set aside by various describers of new coccidian species.

Although the hurried application of a name may be defended, perhaps, on the ground that it provides a convenient handle for subsequent manipulation of the observations—including the final toss into oblivion—nevertheless, limited accounts based on a few oocysts from one or two uncontrolled hosts are not always convincing as descriptions of new species. This appears to be true in the case of avian coccidia for the following reasons:

(a). The actual source of the oocysts may be in doubt, as discussed above.

(b). Oocyst-size, which certainly must be relied upon to some extent, is not without its limitations as a criterion for species differentiation. Some time ago, the writer (2) undertook a detailed study of this character in natural *Isosporan* infections in English sparrows. The mean size of oocysts varied so much that a single set of 50 or 100 measurements could not be considered representative of the infection as a whole. If we assume that mean size and variability in size remain constant for a given species under various conditions, then the statistically significant differences demonstrated for oocysts from sparrows must be due to the presence of more than one species in the same host. It follows that unless a natural infection is observed for some time, in order to check for significant variations, the possibility that a single host may harbor more than one species must be considered, and until this is ruled out, an isolated series of measurements can have little specific value. Further, it is

not impossible that two species may have statistically identical measurements.

(c). Cross infection experiments seem to be required, especially in the case of passerine infections. Sjöbring (21) suggested that there may be several varieties of coccidia in small birds, each one being pathogenic for its particular host. Laveran (19) and Wasielewski (23) have likewise pointed out the need for cross-inneculation experiments. After examining the oocysts from a number of passerine birds, Henry (14) was led to deliver the following ultimatum: “. . . one must draw the conclusion that only one species, *Isospora lacazii*, is represented. At least, with our present methods of differentiation of species, no other conclusion is possible. If experiments could be carried out with these species as easily as with chickens, our knowledge of this form might be extended.”

In the present state of our knowledge, it would seem more important to study the distribution of the genus *Isospora* among avian-groups than to establish species. Detailed studies on certain hosts recorded in this paper may eventually aid in the latter. Perhaps it will be possible to study host-specificity by using super-imposed infections. In only one case thus far, the birds of paradise, do the writer's observations seem to warrant the description of a new species. This has been done elsewhere (5).

The following list of avian hosts of *Isospora* includes 176 species and sub-species of birds, representing 130 genera, 40 families, and 9 orders. Over half of these (94 out of 175) are new host records.

BIRD HOSTS OF *Isospora*

ORDER FALCONIFORMES

FAMILY ACCIPITRIDAE—HAWKS

Accipiter cooperii (Bonaparte). Cooper's hawk. U. S., III (14). California.

Buteo borealis calurus Cassin. Western red-tailed hawk. U. S., III (14). California.

Buteo swainsoni Bonaparte. Swainson's hawk. U. S., III (14). California.

Haliastur indus intermedius (Gurney). Malayan Brahminy kite. P. I., I. sp. (13). P. I.

FAMILY FALCONIDAE—FALCONS

Falco sparverius sparverius Linn. Eastern sparrow hawk. U. S., III (14). California.

Microhierax erythrogenys (Vigors). Philippine falconet. P. I., I. sp. (13). P. I.

ORDER GALLIFORMES

FAMILY TETRAONIDAE—GROUSE

Tetrao urogallus urogallus Linn. Capercailly. Eu., II (10). Switzerland
Lyrurus tetrix tetrix (Linn.). Black grouse. Eu., II (9). Switzerland.

ORDER CHARADRIIFORMES

FAMILY CHARADRIIDAE—PLOVERS, TURNSTONES, SURF-BIRDS

Vanellus vanellus (Linn.). European lapwing. Eu., I. sp. (20). Italy.
Charadrius vociferus vociferus (Linn.). Killdeer. U. S., I (14). California.

ORDER CUCULIFORMES

FAMILY MUSOPHAGIDAE—PLAINTAIN-EATERS

†*Turacus leucotis donaldsoni* Sharpe. Donaldson's Turaco. Afr., I. sp. (*). New York City.

FAMILY CUCULIDAE—CUCKOOS

Cuculus canorus canorus Linn. European cuckoo. Eu., Ib (21). Sweden.

ORDER STRIGIFORMES

FAMILY STRIGIDAE—OWLS

†*Bubo virginianus pallescens* Stone. Western horned owl. U. S., III (14a). Washington.
Asio flammeus flammeus (Pontoppidan). Short-eared owl. U. S., III (14, 14a). California, Washington.
Asio flammeus leucopsis (Brem). Siberian short-eared owl. Asia, IV (29). Taschkent.

ORDER MICROPODIFORMES

FAMILY MICROPODIDAE—SWIFTS

Apus apus apus (Linn.). European swift. Eu., I (17). France.

ORDER CORACIIFORMES

FAMILY ALCEDINIDAE—KINGFISHERS

Alcedo atthis ispida Linn. European kingfisher. Eu., I (17). France.
Halcyon coromandus (Latham). Ruddy kingfisher. P. I., I. sp. (13). P. I.

FAMILY CORACIIDAE—ROLLERS

Coracias garrulus garrulus Linn. European roller. Eu., I (17). France.

FAMILY UPUPIDAE—HOOPOES

Upupa epops epops. European Hoopoe. Eu., I (17). France.

ORDER PICIFORMES

FAMILY CAPITONIDAE—BARBETS

- †*Cyanops asiatica asiatica* (Latham). Blue-cheeked barbet. India, *I. sp.* (*). New York City.

FAMILY PICIDAE—WOODPECKERS

- †*Colaptes auratus luteus* Bangs. Northern flicker. U. S., *I. sp.* (**). Ohio.
Colaptes cafer collaris (Gmelin). Western red-shafted flicker. U. S., I (14). California.
Picus viridis viridis Linn. Green woodpecker. Eu., Ib, I (21, 9). Sweden, Switzerland.
Dryobates minor comminutus (Hart). Br. lesser-spotted woodpecker. Eu., I (18). France.
Jynx torquilla torquilla Linn. Wryneck. Eu. Ib (21). Sweden.

ORDER PASSERIFORMES

FAMILY TYRANNIDAE—NEW WORLD FLYCATCHERS

- †*Sayornis phoebe* (Latham). Eastern phoebe. U. S., *I. sp.* (**). Ohio.

FAMILY ALAUDIDAE—LARKS

- Alauda arvensis arvensis* Linn. European skylark. Eu., I (16, 17, 19, 23). France (twice), Germany.
Galerida cristata cristata (Linn.). Crested lark. Eu., I (17). France.
†*Otocoris alpestris alpestris* (Linn.). Northern horned lark. U. S., *I. sp.* (**). New Jersey.
†*Otocoris alpestris actia* Oberholser. California horned lark. U. S., *I. sp.* (14a). California.

FAMILY HIRUNDINIDAE SWALLOWS

- Riparia riparia riparia* (Linn.). Bank swallow. Eu., I (17). France.
Hirundo urbica urbica Linn. European martin. Eu., I (17). France.
Chelidon rustica rustica (Linn.). European swallow. Eu., I (17). France.

FAMILY CAMPEPHAGIDAE—CUCKOO-SHRIKES

- Lalage niger* (Forster). Pied lalage. P. I., *I. sp.* (13). P. I.

FAMILY ORIOLIDAE—OLD WORLD ORIOLES

- Oriolus oriolus oriolus* (Linn.). European golden oriole. Eu., I (17). France.

FAMILY CORVIDAE—JAYS, CROWS, MAGPIES

- †*Amphelocoma californica californica* (Vigors). California jay. U. S., *I. sp.* (14a). California.
†*Amphelocoma californica immanis* Grinnell. Long-tailed jay. U. S., *I. sp.* (14a). California.
†*Amphelocoma californica oocleptica* Swarth. Nicasio jay. U. S., *I. sp.* (14a). California.
Corvus brachyrhynchos brachyrhynchos Brehm. Eastern crow. U. S., *I. sp.* (1, **). Minnesota, New Jersey.

- †*Corvus brachyrhynchos hesperis* Ridgway. Western crow. U. S., *I*. sp. (14a). California.
- †*Corvus caurinus* Baird. Northwestern crow. U. S., *I*. sp. (14a). Washington.
- Corvus cornix cornix* Linn. Hooded crow. Eu., Ib (21). Sweden.
- Corvus corone corone* Linn. European carrion crow. Eu., I (17, 23). France, Germany.
- Corvus monedula collaris* Drummond. Collared jackdaw. Asia, VII (28). Taschkent.
- Nucifraga caryocatactes caryocatactes* (Linn.). Nutcracker. Eu., V (11). Switzerland.
- †*Dendrocitta rufa rufa* (Latham). Wandering tree magpie. India, *I*. sp. (*). New York City.
- †*Pica pica pica* Linn. European magpie. Eu., *I*. sp. (*). New York City.

FAMILY PARADISEIDAE—BIRDS OF PARADISE

- Paradisaea apoda apoda* Linn. Greater bird of paradise. New Guinea, VI (4). New York City.
- Paradisaea apoda salvadori* Mayr and Rand. Count Salvadori's bird of paradise. New Guinea, VI (4). New York City.
- Paradisaea guilelmi* Cabanis. Emperor of Germany's bird of paradise. New Guinea, VI (4). New York City.
- Paradisaea minor minor* Shaw. Lesser bird of paradise. New Guinea, VI, (4). New York City.
- Paradisornis rudolphi rudolphi* Finsch. Prince Rudolph's bird of paradise. New Guinea, VI (4). New York City.
- Parotia lawesi lawesi* Ramsay. Lawes' six-plumed bird of paradise. New Guinea, VI (3, 4). Milwaukee, New York City.
- Epimachus meyeri meyeri* Finsch. Long-tailed bird of paradise. New Guinea, VI (4). New York City.
- Seleucides melanoleucus melanoleucus* (Daudin). Twelve-wired bird of paradise. New Guinea, VI (4). New York City.
- Lophorina superba minor* Ramsay. Lesser superb bird of paradise. New Guinea, VI (4). New York City.
- Uranornis rubra* (Daudin). Red bird of paradise. New Guinea, VI (4). New York City.
- Manucodia chalybatus orientalis* Salvadori. Blue manucode. Papuan Islands, VI (4). New York City.

FAMILY PARIDAE—TITMICE

- Parus caeruleus caeruleus* Linn. Continental blue titmouse. Eu., Ia, I (16, 17). France.
- Parus major major* Linn. Great titmouse. Eu., I (23). Germany.
- †*Baeolophus inornatus inornatus* (Gambel). Plain titmouse. U. S., *I*. sp. (14a). California.

FAMILY SITTIDAE—NUTHATCHES

- †*Sitta carolinensis carolinensis* Latham. Northern white-breasted nuthatch. U. S., *I*. sp. (**). Ohio.
- †*Sitta carolinensis aculeata* Cassin. Slender-billed nuthatch. U. S., *I*. sp. (14a). California.

FAMILY TIMALIIDAE—BABBLING THRUSHES

- †*Leioptila capistrata capistrata* (Vigors). Black-headed sibia. India, *I. sp.* (*). New York City.
- †*Pyctorhis sinensis sinensis* (Gmelin). Golden-eyed babler. India, *I. sp.* (*). New York City.
- †*Mesia argenteauris argenteauris* Hodgson. Silver-eared hill-tit. India, *I. sp.* (*). New York City.
- †*Liothrix lutea lutea* (Scopoli). Red-billed hill-tit. China, *I. sp.* (*). New York City.
- †*Garrulax leucolophus leucolophus* (Hardwicke). White headed jay thrush. India, *I. sp.* (*). New York City.
- †*Garrulax albogularis albogularis* (Gould). White-throated jay thrush. India, *I. sp.* (*). New York City.
- †*Trochalopteryx lineatum* (Vigors). Streaked jay thrush. India, *I. sp.* (*). New York City.

FAMILY PYCNONOTIDAE—BULBULS

- †*Otocompsa flaviventris flaviventris* (Tick.). Black-crested yellow bulbul. India, *I. sp.* (*). New York City.
- †*Chloropsis aurifrons aurifrons* (Temm.). Golden-fronted green bulbul. India, *I. sp.* (*). New York City.
- †*Molpastes haemorrhous bengalensis* Blyth. Bengal black bulbul. India, *I. sp.* (*). New York City.

FAMILY TROGLODYTIDAE—WRENS

- †*Troglodytes aëdon aëdon* Vieillot. Eastern house wren. U. S., *I. sp.* (**). Ohio.

FAMILY MIMIDAE—THRASHERS, MOCKINGBIRDS

- †*Mimus polyglottos leucopterus* (Vigors). Western mockingbird. U. S., *I. sp.* (14a). California.
- †*Mimus gilvus melanopterus* Lawrence. Black-winged mockingbird. S. A., *I. sp.* (*). New York City.
- †*Dumetella carolinensis* (Linn.). Catbird. U. S., *I. sp.* (**). Ohio.
- †*Toxostoma rufum* (Linn.). Brown thrasher. U. S., *I. sp.* (**). Ohio.
- †*Melanotus caerulescens* (Swainson). Blue mockingthrush. C. A., *I. sp.* (*). Milwaukee.

FAMILY TURDIDAE—THRUSHES

- Turdus migratorius migratorius* Linn. Eastern robin. U. S., *I. sp.* (12, **). Rhode Island, Wisconsin.
- Turdus migratorius propinquus* Ridgway. Western robin. U. S., I (14). California.
- Turdus merula merula* Linn. European blackbird. Eu., I (17, 9). France, Switzerland.
- Turdus iliacus iliacus* Linn. Redwing. Eu., I (8). Switzerland.
- †*Turdus torquatus alpestris* (Brehm). Alpine ring ouzel. Eu., *I. sp.* (*). Milwaukee.
- Hylocichla guttata faxonii* Bangs and Penard. Eastern hermit thrush. U. S., *I. sp.* (12). Rhode Island.

- †*Ixoreus naevius meruloides* (Swainson). Northern varied thrush. U. S., I. sp. (14a). Washington.
- †*Arceuthornis musicus musicus* (Linn.). Red-winged thrush. Eu., I. sp. (*). New York City.
- †*Arceuthornis philomelos philomelos* (Brehm). Continental song thrush. Eu., I. sp. (*). New York City.
- Kittacincla malabarica malabarica* (Scopoli). Indian shama thrush. India, I. sp. (*). New York City.
- †*Sialia sialis sialis* (Linn.). Eastern bluebird. U. S., I. sp. (**). Ohio.
- †*Sialia mexicana occidentalis* Townsend. Western bluebird. U. S., I. sp. (14a). California.
- Oenanthe oenanthe oenanthe* (Linn.). European wheatear. Eu., I. sp. (17). France.
- Erithacus rubecula rubecula* (Linn.). Continental robin redbreast. Eu., I (20, 17). Italy, France.
- Erithacus phoenicurus* (Linn.)? Nightingale. Eu., Ib (21). Sweden.

FAMILY SYLVIIDAE—OLD WORLD WARBLERS

- Sylvia atricapilla atricapilla* (Linn.). Blackcap warbler. Eu., I (20, 17). Italy, France.
- Sylvia borin* (Boddaert). Garden warbler. Eu., I (17, 23). France, Germany.

FAMILY REGULIDAE—KINGLETS

- †*Regulus satrapa satrapa* Lichtenstein. Eastern golden-crowned kinglet. U. S., I. sp. (**). New Jersey.
- †*Polioptila caerulea amoenissima* Grinnell. Western gnatcatcher. U. S., I. sp. (14a). California.

FAMILY MUSCIPIDAE—OLD WORLD FLYCATCHERS

- Fridecula hypoleuca hypoleuca* (Pallas). Pied flycatcher. Eu., Ib (21). Sweden.

FAMILY MOTACILLIDAE—WAGTAILS, PIPITS

- Motacilla alba alba* Linn. White wagtail. Eu., I, Ib (17, 21). France, Sweden.
- Motacilla flava flava* Linn. Blue-headed wagtail. Eu., I (17). France.
- Anthus pratensis pratensis* Linn. European meadow pipit. Eu., I (17). France.
- †*Anthus spinoletta rubescens* (Tunstall). American pipit. U. S., I. sp. (14a). California.

FAMILY LANIIDAE—SHRIKES

- Lanius collurio collurio* (Linn.). Red-backed shrike. Eu., Ia, Ib (16, 21). Sweden.
- Otomela lucionensis* (Linn.). Gray-headed shrike. P. I., I. sp. (13). P. I.

FAMILY STURNIDAE (INCLUDING GRACULIDAE)—STARLINGS, MYNAHS

- Sturnus vulgaris vulgaris* Linn. European starling. Eu., U. S., I, I. sp. (17, **). France, Ohio.
- Sturnia sinensis* (Gmelin). Gray-backed starling. P. I., I. sp. (13). P. I.

- †*Sturnia malabarica malabarica* (Gmelin). Malabar mynah. India, *I. sp.* (*). New York City.
- †*Creatophora carunculata* (Gmelin). Wattled starling. Afr., *I. sp.* (*). New York City.
- †*Temenuchus pagodarum* (Gmelin). Black-headed mynah. India, *I. sp.* (*). Milwaukee.
- Aethiopsar cristatellus cristatellus* (Linn.). Crested mynah. P. I., *I. sp.* (13). P. I.
- †*Gracula religiosa religiosa* Linn. Javan hill mynah. Java, *I. sp.* (*). Milwaukee.
- †*Gracula indica* (Cuvier). Lesser hill mynah. India, *I. sp.* (*). New York City.
- †*Galeospar salvadorii* Sharpe. Crested glossy starling. Afr., *I. sp.* (*). New York City.
- †*Spreo superbus* (Rupp.). Superb glossy starling. Afr., *I. sp.* (*). Milwaukee.
- †*Lamprocorax panayensis halcytipus* Oberholser. Malay glossy starling. Afr., *I. sp.* (*). Milwaukee.

FAMILY VIREONIDAE—VIREOS

- †*Vireo olivaceus* (Linn.). Red-eyed vireo. U. S., *I. sp.* (**). Ohio.

FAMILY COEREBIDAE—HONEY-CREEPERS

- †*Cyanerpes cyaneus* (Linn.). Honey-creeper. S. A., *I. sp.* (*). Milwaukee.

FAMILY COMPSOTHYLPIDAE—WOOD WARBLERS

- †*Geothlypis trichas brachidactyla* (Swainson). Northern yellow-throat. U. S., *I. sp.* (**). Ohio.

FAMILY PLOCEIDAE—WEAVER-FINCHES

- †*Euodice cantans cantans* (Gmelin). African silverbill. Afr., *I. sp.* (*). New York City.
- Euodice malabarica* } Hybrid, Bengalee mannikin. Afr., *I. sp.* (*).
 †*Uroloncha tsriata tsriata* } New York City.
- †*Ploceus velatus arundinarius* (Burch.). Cape or masked weaver. Afr., *I. sp.* (*). Milwaukee.
- Padda oryzivora* (Linn.). White Java sparrow. Java, *I. sp.* (13, *). P. I., New York City.
- †*Taeniopygia castanotis castanotis* (Gould). Zebra finch. Australia, *I. sp.* (*). New York City.
- †*Amandava amandava* (Linn.). Strawberry finch. India, *I. sp.* (*). New York City.
- Amadina erythrocephala* (Linn.). Red-headed finch. Afr., *I. sp.* (*). New York City.
- †*Estrilda astrild astrild* (Linn.). St. Helena waxbill. Afr., *I. sp.* (*). New York City.
- †*Estrilda melpoda melpoda* (Vieillot). Orange-cheeked waxbill. Afr., *I. sp.* (*). New York City.
- Passer domesticus domesticus* (Linn.). English sparrow. Eu., U. S. I (Many authors). *Vide* (6).

Passer montanus montanus (Linn.). Mountain or European tree sparrow. Eu., *I. sp.*, I (13, 9). P. I., Switzerland.
Passer italiae (Vieillot). Italian sparrow. Eu., *I. sp.* (20). Italy.

FAMILY ICTERIDAE—BLACKBIRDS, TROUPIALS

- †*Icterus icterus icterus* (Linn.). Common troupial. S. A., *I. sp.* (*). New York City, Miami.
 †*Icterus bullockii* (Swainson). Bullock's oriole. U. S., *I. sp.* (14a). California.
 †*Gymnomystax mexicanus* (Linn.). Giant oriole. S. A., *I. sp.* (*). New York City.
 †*Sturnella neglecta* Audubon. Western meadowlark. U. S., *I. sp.* (14a). California.
Euphagus cyanocephalus (Wagler). Brewer's blackbird. U. S., *I. sp.* (15, 14a). Washington (twice).
 †*Xanthocephalus xanthocephalus* (Bonaparte). Yellow-headed blackbird. U. S., *I. sp.* (14a). California.
 †*Leistes militaris superciliaris* (Bonaparte). Argentine red-breasted blackbird. S. A., *I. sp.* (*). New York City.
 †*Agelaius phoeniceus californicus* Nelson. Bicolored red-winged blackbird. U. S., *I. sp.* (14a). California.
 †*Quiscalus quiscula aeneus* Ridgway. Bronzed grackle. U. S., *I. sp.* (**). Ohio.
 †*Molothrus ater ater* (Boddaert). Eastern cowbird. U. S., *I. sp.* (**). Ohio.

FAMILY THRAUPIDAE—TANAGERS

- †*Thraupis palmarum palmarum* (Wied). Southern palm tanager. S. A., *I. sp.* (*). New York City.
 †*Rhamphocelus brasileus* (Linn.). Brazilian silver-beaked tanager. S. A., *I. sp.* (*). Milwaukee.
 †*Rhamphocelus carbo carbo* (Pallas). Southern silver-beaked tanager. S. A., *I. sp.* (*). New York City.
 †*Cissopis leveriana* (Gmelin). Magpie-tanager. S. A., *I. sp.* (*). New York City.

FAMILY FRINGILLIDAE—GROSBEAKS, FINCHES, BUNTINGS

- †*Richmondia cardinalis carinalis* (Linn.). Eastern cardinal. U. S., *I. sp.* (**). Ohio.
 †*Hydymeles ludovicianus* (Linn.). Rose-breasted grosbeak. U. S., *I. sp.* (**). Ohio.
 †*Passerina ciris* (Linn.). Painted bunting. C. A., *I. sp.* (*). Milwaukee.
Emberiza citrinella citrinella Linn. Yellow hammer. Eu., I, Ib (17, 21, 23, *). France, Sweden, Germany, New York City.
 †*Sycalis flaveola flaveola* (Linn.). Common saffron finch. S. A., *I. sp.* (*). New York City.
 †*Spinus tristis tristis* (Linn.). Eastern goldfinch. U. S., *I. sp.* (**). Ohio.
Carduelis carduelis carduelis (Linn.). European goldfinch. Eu., Ia, I (16, 17, 9). France, Switzerland.
Acanthis cannabina cannabina (Linn.). Linnet. Eu., I (17, 23). France, Germany.

- Chloris chloris chloris* (Linn.). European green finch. Eu., I (17). France.
- Fringilla coelebs coelebs* Linn. Chaffinch. Eu., Ia, I (16, 17, 23). France, Germany.
- Fringilla montifringilla* Linn. Brambling. Eu., I (17). France.
- Coccothraustes coccothraustes coccothraustes* (Linn.). European hawfinch. Eu., I. sp., I (7, 8, 10). Italy, Switzerland (twice).
- Pyrrhula pyrrhula pileata* Macgillivray. British bullfinch. Eu., I (17). France.
- †*Carpodacus mexicanus frontalis* (Say). Common house finch. U. S., I. sp. (14a). California.
- †*Carpodacus purpureus purpureus* (Gmelin). Eastern purple finch. U. S., I. sp. (**). Ohio.
- †*Pipilo erythrophthalmus erythrophthalmus* (Linn.). Red-eyed towhee. U. S., I. sp. (**). Ohio.
- †*Pipilo fuscus albigula* Baird. San Lucas towhee. U. S., I. sp. (14a). California.
- †*Pipilo maculatus falcifer* McGregor. San Francisco towhee. U. S., I. sp. (14a). California.
- †*Passerculus sandwichensis savanna* (Wilson). Eastern Savannah sparrow. U. S., I. sp. (**). Ohio.
- Melospiza melodia melodia* (Wilson). Eastern song sparrow. U. S., I. sp. (**). Ohio, Minnesota.
- †*Chondestes grammacus strigatus* Swainson. Western lark sparrow. U. S., I. sp. (14a). California.
- Junco hyemalis hyemalis* (Linn.). Slate-colored junco. U. S., I. sp. (12). Rhode Island.
- †*Junco oreganus oreganus* (Townsend). Oregon junco. U. S., I. sp. (14a). California.
- Zonotrichia albicollis* (Gmelin). White-throated sparrow. U. S., I. sp. (12, **). Rhode Island, New Jersey.
- †*Zonotrichia leucophrys leucophrys* (Forster). White-crowned sparrow. U. S., I. sp. (14a). California.
- †*Zonotrichia leucophrys gambeli* (Nuttall). Gambel's sparrow. U. S., I. sp. (14a). California.
- †*Zonotrichia coronata* (Pallas). Golden-crowned sparrow. U. S., I. sp. (14a). California.
- †*Spizella passerina passerina* (Bechstein). Eastern chipping sparrow. I. sp. (**). Ohio.
- †*Spizella passerina arizonae* Coues. Western chipping sparrow. U. S., I. sp. (14a). California.
- Spizella pusilla pusilla* (Wilson). Eastern field sparrow. U. S., I. sp. (12, **). Rhode Island, Ohio.

* Author's record on captive bird.

** Author's record on wild bird.

† New host for *Isospora*.

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|---|---|
| I. <i>I. lacazii</i> (Labbé, 1893). | IV. <i>I. strigis</i> Yakimoff and Mat., 1937. |
| Ia. <i>I. rivoltae</i> (Labbé, 1893). | V. <i>I. nucifragae</i> Galli-Valerio, 1933. |
| Ib. <i>I. communis-passerum</i> Sjöbring, 1897. | VI. <i>I. volki</i> Boughton, 1937. |
| II. <i>I. lyruri</i> Galli-Valerio, 1931. | VII. <i>I. monedulae</i> Yakimoff and Mat., 1936. |
| III. <i>I. buteonis</i> Henry, 1932. | |

SUMMARY

The list of avian hosts of the genus *Isospora* recorded in this paper is comprised of 176 species and sub-species of birds. These represent 130 genera, 40 families, and 9 orders. Of the entire list, 94 hosts are reported for the first time: 27 through the courtesy of Dr. Dora P. Henry and 67 representing the author's own observations. Of the latter, 21 were wild hosts examined in their natural habitats and 46 were captive birds.

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Forest Pathology

The more important diseases of forest trees, from the seedlings in the nursery or the forest to the mature veterans ready to harvest, are discussed in this text. Foresters, forestry students, plant pathologists, and shade tree specialists should find it valuable in diagnosing tree diseases. The plan of the book is based on the tree organs affected by disease, such as root, stem, and foliage; since most foresters are not mycologists, this appears to be more satisfactory than the customary organization based on the taxonomic relationships of the causal agents.

The causes of diseases, their expressions in symptoms and signs, and their various classifications are outlined in an early chapter. The trunk or stem of a forest tree is the salable portion, and its diseases are considered in most detail. A discussion of the decay of standing timber, the deterioration of forest products and of sap stains, all of which are of great economic importance to the lumberman and the public, occupies nearly one hundred pages. Foresters generally regard heart rots of standing timber as diseases, even though that portion of the susceptible is non-living.

The principles of forest-disease control are outlined, but only those few measures which fit into routine silvicultural practice are considered. Protection by fungicides and eradication of diseased trees are seldom practiced, because of the relatively low value per unit area of the forest crop. In the nurseries, where unit values are high, direct control measures, such as protection by spraying or dusting, are economically possible.

On the whole, this text appears to be one of the best in its field. Half-tone illustrations are plentiful, and a selected list of references is appended to each chapter.—*A. L. Pierstorff.*

Forest Pathology, by John Shaw Boyce. x+600 pp. New York, the McGraw-Hill Book Company, 1938. \$5.00.

Scientific Illustration

A recent publication entitled "Scientific Illustration" appears to be a very useful book on this subject. It presents methods and equipment essential for the production of satisfactory drawings and illustrations for scientific publications.

Fifty-eight topics are discussed and illustrated. Some of these deal with kinds of illustrations; requirements, methods and equipment useful in the preparation of drawings, especially natural history drawings; light and shade effects; photographs, their composition and preparation; proof reading illustrations and the process of reproducing illustrations. A number of topics discuss and illustrate thoroughly maps and their preparation. This should be of decided interest and value to geographers and geologists.

The illustrations, found on the 22 plates and among the 23 figures, are especially good and illustrate high grade scientific work. In general the book should be very useful to advanced students and investigators looking for suggestions on how to prepare illustrations for their scientific publications.—*Alvah Peterson.*

Scientific Illustration, by J. L. Ridgway. 173 pp., 22 plates, 23 figures. Stanford University Press, Stanford University, California. 1937. \$4.00.

THE ALIMENTARY CANAL OF THE APHID *PROCIPHILUS TESSELATA* FITCH.

JOHN Z. PELTON,
Ohio State University

INTRODUCTION

The Woolly Alder Aphis (*Prociphilus tessellata* Fitch), is a sucking insect feeding on alder. It is commonly found throughout the State of Ohio.

The study that follows was made upon the suggestion of Dr. C. H. Kennedy, and was begun in a course on "The Morphology and Development of Insects."

The material used was collected on the bank of Minerva Lake, at Columbus, Ohio, October 9, 1936. The aphids were brought into the laboratory and kept alive on a branch of alder for several weeks. Live material was kept alive in the laboratory and used from time to time over a period of five weeks. Specimens were opened and fixed in Kahle's solution for 24 hours, and preserved in 70% alcohol.

The author wishes to express his appreciation for the helpful suggestions and criticisms of Dr. C. H. Kennedy, under whose direction this study was made.

GROSS ANATOMY OF THE DIGESTIVE TRACT

General Anatomy

The alimentary canal consists of a long tube with a few convolutions, which is characteristic of sucking insects. The canal is approximately two and one-half times the length of the insect's body. Morphologically the canal is divisible into three primary regions according to their embryonic origin. The fore-intestine (stomodaeum) arises as an anterior ectodermal invagination, the hind-intestine (proctodaeum) arises as a similar posterior invagination; while the epithelium on the mid-intestine arises from embryonic endoderm, the muscular layers in the same region are derived from mesodermal tissue.

Fore-Intestine

The fore-intestine is a comparatively short, slender tube which consists of the following regions: pharynx, oesophagus, and oesophageal valve.

The pharynx is the slight enlargement of the fore-intestine just posterior to the mouth which connects the mouth with the oesophagus.

The oesophagus is a short, narrow tube connecting the pharynx with the mid-intestine (Pl. I, fig. 1). It is located running through the prothorax and mesothorax. At the junction of the oesophagus

and the mid-intestine is located the oesophageal valve which projects into the lumen of the mid-intestine.

The oesophageal valve is rather well developed and marks the division between the fore-intestine and mid-intestine. It is found near the junction of the mesothoracic and metathoracic segments.

The salivary glands are represented by two small oval bodies located dorsally, left and right respectively to the oesophagus between the prothoracic and mesothoracic segments (Pl. I, fig. 1). They connect with the oesophagus by a simple forked tube.

Mid-Intestine

The mid-intestine, mesenteron, forms about two-thirds of the alimentary tract (Pl. I, fig. 1). It is marked at its anterior end by the oesophageal valve, located near the anterior part of the metathoracic segment, and at the posterior end by the pyloric valve located in the first abdominal segment. The size of the mid-intestine or stomach varied with the different specimens dissected. The anterior part of the mid-intestine is shaped like a large bulb with a small constriction at the posterior part of the bulb. The stomach runs posteriorly to the ninth abdominal segment where a turn occurs, a short lateral wave with a complete reverse turn cephalad to the middle of the metathoracic segment where it folds a figure U dorsally on the bulb part of the stomach. After forming the U, the stomach bends down around the bulb part and turns back posteriorly on the ventral side of the bulb, where the pyloric valve occurs in the anterior part of the first abdominal segment, or as far forward as the metathorax. No malpighian tubules were found. Weber, in his "Lehrbuch der Entomologie," states that aphids lack malpighian tubules.

Hind-Intestine

The hind-intestine lacks malpighian tubules, and consists of a pyloric valve and a sac-like portion, having the structure of a rectum, which gradually enlarges toward the anus. G. F. Knowlton found the hind-intestine of *Longistigma caryae* (Harris) connects with the anus by a thick-walled rectum which has only a small opening through the center.

The pyloric valve is recognized by the constriction at the posterior end of the mid-intestine (Pl. I, fig. 5). It is located in the posterior part of the metathoracic segment, or in the first abdominal segment.

HISTOLOGY OF THE ALIMENTARY CANAL

Fore-Intestine

The fore-intestine is histologically composed of the same parts throughout its length, but there is some variation in development of the parts.

The intima, or cuticula of chitin, is homologous with the cuticula of the body-wall. It is thin and very delicate for most of the distance through the fore-intestine, which it lines throughout.

The epithelium is thin, the cells are small rectangular, the nuclei of medium size, oval to round and quite centrally located. Nucleus

and cytoplasm are granular. The basement membrane cannot be distinguished.

Outside of the epithelial layer are found delicate scattered strands of longitudinal muscles at irregular intervals.

Surrounding the longitudinal muscles is a fairly continuous layer of circular muscles.

The oesophageal valve (Pl. I, fig. 4), marks the junction of the fore-intestine with the mid-intestine. The valve consists of a fold of epithelium, delicate cuticula from the oesophagus, which extends well into the fore-end of the mid-intestine. The folds of epithelium then turn back and join the large stomach digestive epithelium cells at the point where the oesophagus enters the mid-intestine. Histologically the parts coincide with the same structures in the oesophagus.

Mid-Intestine

The mid-intestine or stomach is the part of the alimentary canal posterior to the oesophageal valve and anterior to the pyloric valve.

The mid-intestine is quite long, being about two-thirds the length of the entire tract and easily distinguished from the other parts of the tract.

No evidence of the peritrophic membrane could be found. G. F. Knowlton, working on *Longistigma caryae*, found: "The peritrophic membranes or some membranous tissue is found covering the inner surface of the digestive epithelium cells in the closed and partly closed portion of the stomach, but is not present apparently, in the open stomach except where no signs of recent digestion are in evidence."

The ring of columnar shaped cells in the stomach around the oesophageal valve (Pl. I, fig. 4) may be the remains of the cells that secrete the peritrophic membrane in such insects as have a peritrophic membrane. E. P. Breakey, working on *Anasa tristis*, found a similar ring of cells and suggested that they may represent a ring of "peritrophic cells." So it appears for the first time that a circle of "peritrophic cells" has been found in Aphids.

The digestive epithelium is composed of large irregular cells with large oval nuclei, and the cytoplasm as well as the nucleus granular.

The basement membrane is a rather thick, structureless membrane and quite distinct.

The muscular layer is composed of circular fibers next the basement membrane, outside of which are thin strands of longitudinal fibers. The order of these layers is just the reverse of that of the muscular layers on the oesophagus, where the longitudinal fibers are inside the layer of circular fibers. The two layers are reversed at the oesophageal valve where the bundles of fibers interlace.

Hind-Intestine

The hind-intestine, more than half as long as the aphid, is marked anteriorly by the pyloric valve and posteriorly by the anus.

The pyloric valve, (Pl. II, fig. 9), consists of a slight constriction and differentiation of cells. The large irregular cells of the mid-intestine end abruptly and the irregular columnar cells of the hind-intestine arise. For the first time, so it appears, a pyloric valve has been found and

identified in the Aphids. This pyloric valve lacks a muscular band and cannot close. As a result, the pyloric valve is not a true valve as such. The intima is delicate but clearly distinguishable.

The epithelium consists of irregular columnar shaped cells with oval shaped nuclei and with the cell walls seldom distinguishable.

The hind-intestine gradually enlarges into a rectum (Pl. II, fig. 10), the cells increasing slightly in size.

The basement membrane of the epithelium is structureless and rather indistinct.

The inner circular muscles form a delicate layer throughout the length of the hind-intestine. The longitudinal muscles are delicate, scattered strands. No outer circular muscles are in evidence.

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EXPLANATION OF PLATES

PLATE I

- Fig. 1. Gross dissection; dorsal view of alimentary canal and salivary glands to show relative size and relation of parts.
 Fig. 2. Cross-section through a salivary gland.
 Fig. 3. Cross-section through the oesophagus.
 Fig. 4. Longitudinal section through a portion of the oesophagus, the oesophageal valve and part of the stomach.
 Fig. 5. Gross dissection; ventral view of portion of alimentary canal showing relative size and location of pyloric valve.
 Fig. 6. Cross-section through constriction at posterior end of bulb part of mid-intestine.

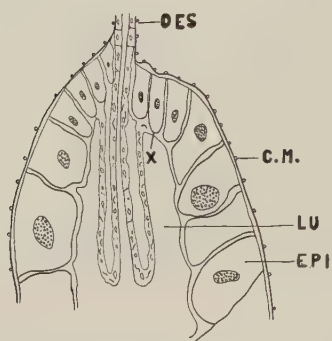
PLATE II

- Fig. 7. Cross-section through stomach at oesophageal valve.
 Fig. 8. Cross-section through mid-intestine below constriction.
 Fig. 9. Longitudinal section through pyloric valve.
 Fig. 10. Cross-section through hind-intestine, rectum.

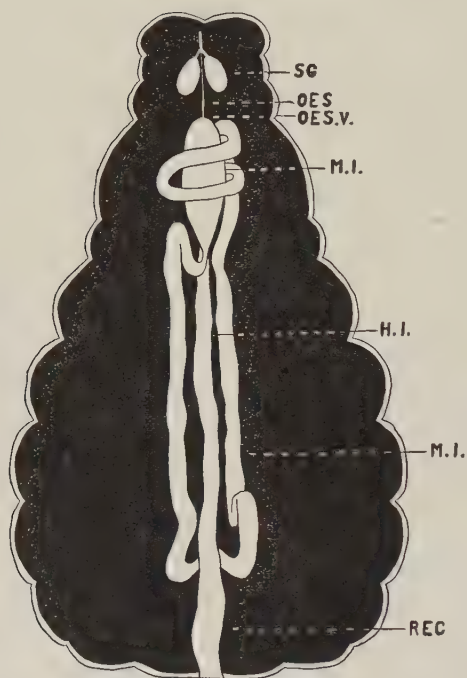
KEY TO ABBREVIATIONS

C. M.—Circular Muscle.
 EPI.—Epithelium.
 H. I.—Hind-intestine.
 INT.—Intima.
 LU.—Lumen.
 MI.—Mid-intestine.
 Oes.—Oesophagus.

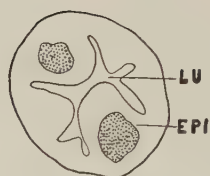
Oes. V.—Oesophageal Valve.
 P. O.—Projection of oesophagus.
 P. VLV.—Pyloric Valve.
 R. C.—Regenerative cell.
 REC.—Rectum.
 S. G.—Salivary Gland.
 X—Columnar "peritrophic cell."



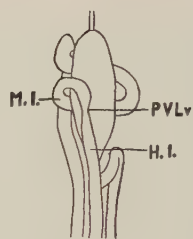
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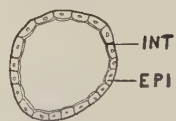
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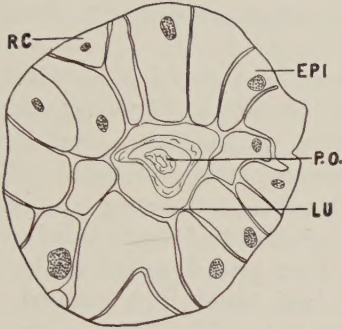
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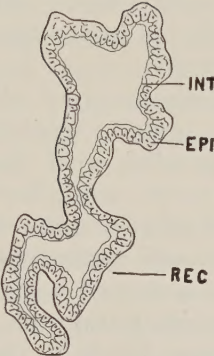
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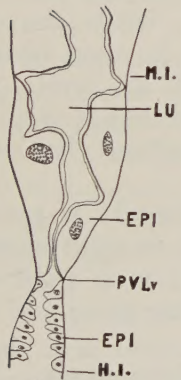
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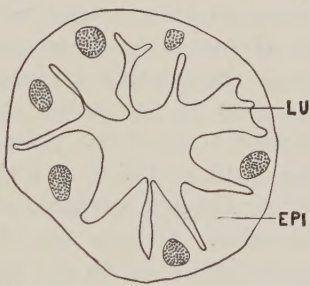
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LEVEL OR FLAT?

GEORGE D. HUBBARD,
Oberlin College

I have been annoyed sometimes by the use of the words "level" and "flat." They are too frequently used synonymously or at least, flat is too often used where level is the correct word.

This discussion, I think, can be started at a place where all will agree. According to Huxley's *Physiography*¹ level means parallel with the surface of the sea. Sea level is a familiar term, and, barring many little technical differences as to just what to adopt as sea level for a datum plane in surveying, men will agree with Tarr,² Hobbs,³ and Salisbury⁴ that "level is a curved surface." Tarr and Martin⁵ make a point in a special paragraph that "sea level is a curved surface, conforming closely to the oblate spheroidal form of the earth." They also state that the ocean floor is in the main level, and they explain that they mean that it is roughly parallel to the surface of the sea—a curved surface. While the matter is not always so clearly and fully stated, in most books in our fields level seems to mean parallel with sea level. In many books too, the earth's surface is said to depart from level by the flattening at the poles, or to be less level, less convex, or less rounded toward the poles.

Some authors point out that "horizontal" is parallel with sea level or the sea surface, or that it is at right angles to the perpendicular. Others say that "level" is at right angles to the perpendicular or to the earth's radius; some add "at right angles to any radius or to all radii."

Dictionary definitions are derived from usage. Webster's *International* gives literal and figurative definitions and the

¹*Physiography*, T. H. Huxley and R. A. Gregory, pp. 214-215, 349-350. Macmillan and Company, London, 1905.

²*The New Physical Geography*, R. S. Tarr, pp. 9, 179. The Macmillan Company, New York, 1904.

³*Earth Features and Their Meaning*, W. H. Hobbs, p. 245. The Macmillan Company, New York, 1931.

⁴*Physiography*, R. D. Salisbury, pp. 400, 707. Henry Holt and Company, New York, 1913.

⁵*College Physiography*, R. S. Tarr and Lawrence Martin, pp. 640, 644. The Macmillan Company, New York, 1914.

first group all involve horizontality, rectilinearity, or equipotentiality as to gravity.

With this unanimity of usage and definition it ought not to be difficult for physiographers and geologists to be reasonably consistent in the use of "level."

The term "flat" may be made as valuable as "level" has become if we were willing. I turn to the Thesaurus and find the whole discussion of when to use flat centers on flatness as opposed to convexity, protuberance, and roundness. In geometry a flat surface and a plane are used synonymously, and a flat surface can stand in any position with reference to the perpendicular. In usage it has nothing to do with perpendicular, or with horizontal, or with gravitation. It may be as smooth as a level surface but it is not level. It may be thought of at times as tangent to a level surface but never coincident with it.

With reference to drainage, flat and level have meaning. A level surface cannot be drained because it is everywhere at right angles to the perpendicular; there is no grade, no slope, no difference of potential as to gravity. A flat surface of land must be tangent to the sphere or to a level surface at some point. It drains with ease because the potential upon it increases everywhere toward that point of tangency. Suppose the position of a flat surface were that of tangency of the earth, and at right angles to our radius. It could not be at right angles to any other radius. With reference to the earth's surface, the level surface, it would rise on all sides or in all directions from the point of tangency.

Six such flat surfaces tangent to a sphere and placed at radii equally spaced, 90° apart, would constitute a cube. The edges of such flat surfaces inclosing the earth would make dihedral angles of 90° , mountain crests rising 1,300 to 1,400 miles high with slopes of 45° ; and the trihedral angles of the circumscribed cube would be still higher. On an earth of the size of ours, bounded by six flat surfaces, our seas, if uniformly distributed, would be six similar deep seas and there could be no communication between the several seas until much leveling had taken place. No doubt gravity would manage most of the leveling.

This study resembles two others that only need to be suggested. The first may be approached by the question, "Do you go uptown or downtown? up to Cleveland or down to Cleveland? up or down to Cincinnati?" In the use of maps

do you describe everything as "up" that is toward the top of the map, or even toward the north? Do you go down the Atlantic coast and down to South America? up to the north pole or Greenland? One might go up or down stream but not up north or down south. Let's get over such unscientific statements.

The second is equally obvious when indicated. Do you say, in pointing to a map illustrating your talk, "The waterfalls are right here?" Why not say, "up the river 9 miles from Columbus." One still might then point to Columbus and Hayden's Falls on the map without affirming that they have been brought into captivity or spread upon the wall.

One might here open the discussion of the use of the terms "plane" and "plain" in physiographic description. If plains are due to degradation or to aggradation most of them are more or less level and not flat. The geometers have reserved "plane" for flat surfaces. Let us let them have it. I do not care to push this point further today, even in the interest of more exact scientific expression.

Electrons for Everybody

Popular books on scientific subjects are enjoying a tremendous vogue these days, and even such abstruse subjects as electronics have not been overlooked. This frankly popular exposition of the electron and its modern wonders will appeal to the layman because of its sheer dramatization of things in which everyone is interested. The story of the attempt—and its gradual success—to unlock the unfathomed sources of energy resident in the nuclei of the atoms of matter is inherently a dramatic one, and from this standpoint it is told well. The applications of electronics to music, radio, television, medicine, surgery and industry are vividly unfolded. The book is just what it claims to be, a popular story of "these amazing electrons."—*L. H. S.*

These Amazing Electrons, by Raymond F. Yates. vii+326 pp. New York, The Macmillan Co. 1937.

Cytological Technique for Plant Breeders

Plant breeders of today are employing methods of the cytologist more frequently, since many breeding problems have been solved by such technics. Unfortunately the practical man too often is overwhelmed and thoroughly discouraged when he attempts to obtain cytological technics from the literature because of inadequate descriptions and a cloak of unfamiliar terminology. This booklet is a worthy attempt at simplifying and concentrating technics usable by the breeder. The text consists of ten pages. A one-page appendix lists formulae for several fixatives. The short bibliography could have been extended profitably.

—*Glenn W. Blaydes.*

An Outline of Cytological Technique for Plant Breeders. Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England, 1937. Price 1/6.